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ERRATA IN VOL. XI

Page 42, at bottom, *delete* table and *substitute* :—

Plot.	Half-year ended June 30, 1909, barrels per acre.	Year ended June 30, 1910, barrels per acre.	Total barrels per acre.	Total barrels per plot.
1	4	40	44	11
2	51	220	271	67¾
3	4	40	44	11
4	8	44	52	13
5	5	48	53	13¼

Page 43, line 3, *for* '55' *read* '220'.
Page 43, line 11, *for* '106' *read* '68'.
Page 43, line 13, *for* '19' *read* '13'.
Page 79, line 36, *for* '*Corticum*' *read* '*Corticium*'.
Page 85, line 37, *for* '*Diatreae*' *read* '*Diatraea*'.
Page 187, last line but one *for* 'Perdix' *read* 'Perdrix'.
Page 227, second sub-heading, *for* 'on' *read* 'of'.
Page 251, lines 17 and 18, *for* 'to which Sir Daniel Morris . . . . . was attached as secretary' *read* 'to which Sir Daniel Morris was attached as scientific adviser'.
Page 333, line 34, *for* 'Cystosyora' *read* 'Cystospora'.
Page 355, line 34, *for* '*Phaseolus lunatus*' *read* '*Phaseolus Mungo*'.
Page 377, lines 10 and 11, *for* '*Ischaemum augustifoluim*' *read* '*Ischaemum angustifolium*'.
Page 387, last line but two, *for* 'Columbia' *read* 'Colombia'.
Page 449, line 8, *for* 'pp. 231' *read* 'pp. 231-450'.
Page 449, *add* 'Lectures to Sugar Planters, issued in 1906'.

It has been recognized for a comparatively long time, that different species of fungi are able to attack the bodies of various living insects and eventually cause their death; but the epidemic nature of this attack, that is the hundreds of thousands of individuals that may be destroyed by the fungus, together with its economic importance, whether beneficial or the reverse, has only been recognized within the last forty years. Indeed, the use of these parasites in the control of various pests is of even more recent date, and cannot yet be said to have attained the greatest application of which it is capable. In fact, it is only within the last two years that the subject has received in the West Indies the attention of which it is worthy, and it may be directly stated, that the results of the observations and experiments conducted during that time offer every prospect of success in controlling scale insect attacks by means of their fungoid parasites.

The first important step in the recognition of the effect of vegetable parasites of insects on an economic scale, was the discovery of the bacterial disease of silk worms by Pasteur in 1870. The disease had occasioned considerable loss to the silk industry in France, but the recognition of its cause led to the suggestion of measures by which it could be prevented satisfactorily.

During the last twenty-seven years, in the United States of America, a considerable amount of work has been carried on having a directly opposite object, namely, the reduction of the numbers of various insect pests by means of their vegetable parasites, both bacterial and fungoid. This work has, on the whole, met with a fair measure of success, more especially in the damper and milder climates of the more southern States. Among the insects experimented upon may be mentioned the cabbage caterpillar, the chinch bug, the grasshopper and various species of scale insects.

The scale insects, by virtue of their stationary habit, are particularly liable to attack by fungi, whose hyphae can grow under their scales and destroy their bodies. The usefulness, from an economic point of view, of the fungi attacking these insects has been exploited to the greatest extent in the State of Florida, where Professor Rolfs[20], of the State Experiment Station, first demonstrated, in 1897, the practical application of the red-headed fungus in the control of the San José scale. Subsequent work by various members of the Experiment Station staff has added very largely to our knowledge of such fungi, and of the conditions under which they may be successfully employed. More recently, information as to the occurrence and distribution of the fungoid parasites of various scale insects has been forthcoming from different parts of the world, including Cuba, Porto Rico, Martinique, Ceylon, South Africa and Australia.

During the last year, information with regard to the distribution and effectiveness of these fungi in the various West Indian Islands has been collected by the officers of the Imperial Department of Agriculture, and the results, though at present far from complete, are embodied in this article, which is intended as a preliminary discussion of the question, and an indication of the lines along which it is hoped subsequent work will be conducted. The fungi at present known to occur in these islands are: the red-headed fungus, *Sphaerostilbe coccophila*, Tul.; the white-headed fungus, *Ophionectria coccicola*, E. and E.; the black fungus, *Myriangium Duriaei*, Mont.; the shield scale fungus, probably *Cephalosporium lecanii*, Zimmermann.

GENERAL DESCRIPTION OF THE FUNGI FOUND IN THE WEST INDIES.

The following is a brief account of the more superficial characters of these fungi; the fuller and more technical description of them will be found in the last part of this article.

RED-HEADED FUNGUS. This most commonly appears as a small, conical, or club-shaped outgrowth from the scale attacked; it is usually inclined at an obtuse angle to the surface of the scale, and is from $\frac{1}{40}$ to $\frac{1}{8}$-inch or $\frac{1}{2}$ to 3 millimetres in length. The end of each outgrowth is bright-red in colour and somewhat horny in consistency. This is supported on a delicate, pinkish, velvety base. As many as five or six of these outgrowths, or *sporodochia*, may arise from a single scale. They are borne on an interwoven mass of the fungal hyphae, known as a stroma, which fills the space once occupied by the body of the dead scale insect. Another form of fructification may also be produced by the fungus. This consists of more or less spherical, smooth, bright-red perithecia, which are usually borne in groups of four or five on the same stroma as the other fruiting form. It must be remembered that the hyphae of this fungus are colourless and fine, and that consequently, when the fungus is not producing either of the forms of fructification described above, it is very hard to see, and may be present in large quantities and doing most effective work, although entirely invisible to the naked eye. Practically the only indication of its presence in this stage, visible without a microscope, is the large number of dead scale insects to be found on the host plant.

WHITE-HEADED FUNGUS. This also has two forms of fructification, both produced, as in the case of the red-headed fungus, on a stroma occupying the body cavity, and also frequently covering the body, of the scale insect. The stroma is white or cream-coloured, and gives rise to a small, brown, cylindrical outgrowth about $\frac{1}{2}$-millimetre long. When this becomes mature, it turns white at the top, owing to the formation of a more or less conical head of white spores. The second stage consists of numerous, more or less spherical, smooth perithecia, of a coffee colour, which occur in groups on the stroma. Owing to the scattering of the conidia over the stroma, the fungus frequently appears white or grey in colour.

BLACK FUNGUS. This appears as irregular, smooth, coal-black lumps on stems and branches of trees infected with scale insects; it rarely occurs on the leaves. The major portion of the black stroma is of a brittle nature, somewhat like charcoal, and the stroma, as a whole, is of a definite appearance. These characters serve to distinguish it from black blight to which, however, it bears in reality but little resemblance. This fungus also consists of fine, nearly colourless hyphae in its early vegetative stages, and probably kills many more scales than those on which its stroma actually appears. While useful on the stems and branches, this fungus is more disfiguring than the scales themselves when it occurs on the fruit. No instance of its occurrence there is, however, recorded at present in these islands, though it has been known to occur on fruit in Cuba.

SHIELD SCALE FUNGUS. This differs very considerably in appearance from any of the other three, its characters being more those of a mould. In the early stages it kills the insects without any outward appearance of its presence such as would be visible to the naked eye. But when the scale is dead a white or slightly buff coloured fringe, often of a rather waxy appearance, grows out from beneath it over the surface of the leaf. The scale itself often becomes brown in colour and of a papery consistency, that is, if it is one of the soft shield scales. At an even later stage the whole surface of the scale insect becomes covered with a slightly buff-coloured coating of the fungus hyphae, and this often has a very powdery surface owing to the presence of very numerous heads of spores. The appearance is most characteristic, and when once seen cannot easily be mistaken.

EFFECTIVENESS OF THE FUNGI.

In treating of the red-headed fungus on the San José scale in Florida, Professor Rolfs[20] remarks that the ordinary observer would overlook it altogether. This would hardly happen in the West Indies in places where the fungus is really active, and producing numerous fructifications, as the result is to give a quite definite pink appearance to the parts affected, even when they are viewed from a short distance. The above effect has been seen by the author on lime tree stems in Dominica; it is also mentioned by the Imperial Commissioner of Agriculture as having been even more noticeable in the case of a specimen of *Castilloa elastica* at the Agricultural School, St. Lucia, on which numerous parasitized scales occurred. These instances serve as an illustration of the effectiveness of this parasite under favourable conditions. In dealing with this point in his paper on 'Fungi Parasitic upon Aleyrodes Citri', Professor Fawcett[12], of the Florida State Experiment Station, remarks:—

'The effective work of this fungus (the red-headed fungus), and of two others, *Ophionectria coccicola*, E. and E., and *Myriangium Duriaei*, Mont., upon the orange scales, is readily shown by spraying an orange tree very thoroughly with Bordeaux mixture. During the summer and fall of 1907, the author sprayed a number of trees with Bordeaux mixture for another purpose. The trees were sprayed very thoroughly, once in May, once in July, and once in September. Before the first spraying, the trees were practically unhurt by *Mytilaspis citricola*, only a few individuals of the scale being found on any part of the trees. After the first spraying, this scale insect began to spread, and increased slowly in numbers until November, when the trees were badly attacked by the scale. Other trees, near by, that had received no spray, were as free from scale as at the first. The fungicide had evidently destroyed, on the sprayed trees, the fungi that had been all along working upon the unsprayed trees.'

Another instance illustrating the same thing is that afforded by Dominica. In this island there has been no serious trouble from scale insects since the year 1903, which succeeded the drought in 1902. Observations on material from the island show that this is to a considerable extent due to the luxurious growths of parasitic fungi, which have kept the scales in check for seven consecutive years.

In their paper on 'Insects and Diseases of the Orange', Cook and Horne[8] remark that the black fungus (*Myriangium Duriaei*) has less effect on the orange snow scale (*Chionaspis citri*) in

Cuba, than any of the other fungi found there have on the insects which they attack. In Dominica, however, it would appear to be more effective, for this scale practically never assumes serious proportions in that island, and could only be said to be of secondary importance in the serious outbreak of scale insects that occurred in 1903. The black fungus is very common on this scale, and probably is responsible to a very large extent for keeping it under control. The same fungus occurs very commonly on this scale in Montserrat. In this island, the snow scale was a very serious pest in the dry year 1903, but has never assumed serious proportions since, except in isolated instances where trees were suffering from drought. This indicates that there also, the black fungus is an efficient check on this scale. The white-headed, and the shield scale fungi (*Ophionectria coccicola* and *Cephalosporium lecanii*) are equally effective, as far as present observations show; but as the first only occurs in Dominica, it is not possible to state how useful it would be under the drier conditions experienced in some of the other islands. Experiments will, however, be made to introduce it more generally, as it is almost the most vigorous of these fungi, when under favourable conditions.

METHODS OF EMPLOYING THE FUNGI.

In some districts, where the general conditions are favourable to their growth, the parasites of certain species of insects exist naturally in large numbers. These parasites are responsible, under normal conditions, for the comparative rarity of these species in those districts. Such districts are usually spoken of as being unsuited to the species—a phrase which simply means that, in the battle between the host and the parasite, the natural conditions favour the parasite, and the numbers of the host are consequently kept at a minimum. Man's work in making use of these parasites is of two kinds: firstly, to introduce the parasite into districts in which the conditions are favourable to its growth, but in which it has not previously been known to occur; and secondly, to produce, where possible, by artificial means, conditions which are favourable to the parasites in districts where the conditions in general are not favourable. Some methods of achieving both of these objects will now be dealt with.

Three methods of introducing these fungi into fields where they have not previously been known to exist have been found to be successful in Florida, according to Dr. E. W. Berger[1] of the State Experiment Station; but time has not yet permitted of any very definite observations on their effectiveness in the West Indies.

The first method consists of spraying the spores and portions of the mycelium of the fungi on to the trees which it is intended to infect. For this purpose, leaves well infected with the fungus should be stirred up for ten to fifteen minutes in water; there should be about forty fructifications of the fungus, or more, to each pint of water. The mixture should then be strained through a fine wire mesh, or a coarse muslin, and sprayed on to the trees. The author referred to above recommends that an iron sprayer or atomizer should be used for this purpose, or if the operation is to be conducted on a large scale, a compressed air sprayer with a galvanized iron receptacle. It seems, however, that if the liquid to be employed is carried in a galvanized iron bucket and not in a brass or copper receptacle, a brass syringe might be used with perfect safety, provided it is emptied as soon as it has been filled, and had not previously been employed for fungicides. The spray should be as fine as possible, as the trees should be sprinkled only, not soaked, any water that runs off representing a direct loss of spores. If the above precautions are carefully attended to, it is usually found that this method of artificial infection is the most successful of the three. The fungus material for mixing with water may also be taken from pure cultures; purely technical methods are required to obtain these, but when once obtained, they could be kept constantly in stock in the Laboratory of this Department and distributed as required, thus enabling experiments to be carried on at those seasons of the year when fructifications of the fungi are not easily procurable in the field. When it is intended to infect only one or two trees for experimental purposes, it may be found that a large glass syringe with as fine a delivery nozzle as possible is a good instrument for spraying the trees.

This method may be employed for all the species of fungi found in the West Indies, with the exception of the black fungus (*Myriangium Duriaei*), whose spores are formed in such a way that they would not necessarily be liberated when portions of it are shaken with water.

The second method, which is applicable to all the fungi, consists in tying infected material into trees which it is desired to infect. This should be done in such a manner that the fructifications of the fungi come into as close proximity to healthy scale insects as possible. This method, according to Dr. E. W. Berger[4], ranks second in order of efficiency in Florida, and should certainly yield successful results here.

The third method has not proved as successful as the other two, and has the additional disadvantage of being considerably more expensive in application. It consists in planting among the trees to be infected, small trees whose foliage is well infected with various parasitic scale fungi, so that the leaves of the small trees come into contact with those of the larger ones. If necessary, such trees may be planted in pots or tubs and raised on platforms. This method has the disadvantage of not spreading the fungus as effectively over a wide area as in the other cases, and involves certain difficulties in watering in order to prevent the small trees from dropping their leaves.

The tying method is the one that commends itself as that most likely to be successful here, on account of the general conditions that prevail on estates; though spraying with spores will probably also prove useful, especially for a small number of trees.

In order to have a ready supply of these fungi always available, it is advisable, as far as possible, for every manager or planter, especially on lime estates, to be acquainted with some place where he can be certain of obtaining one or more of them. For this purpose, he should watch some particular tree known to be well infested, and when he notices that the scales are nearly all killed, should transfer the fungi to a neighbouring tree where there are scale insects in considerable numbers.

With regard to the artificial formation of conditions suitable to these fungi in localities where they are naturally unfavourable, there are two courses which may be followed. The main difficulties which have to be overcome are the effects of a bad drought, especially in the dry season, and those of wind.

In most of the islands, with the possible exception of Barbados and Antigua, the general conditions in the wet season are sufficiently favourable to permit of the fungi making good growth. Consequently, the only period when artificial help is necessary is during the dry season ; it will probably be found that spraying one or two trees with clean water, once or twice a week, would enable the fungi to tide over the unfavourable conditions, and so afford a starting point from which they could spread again in the wet season. The other method, which is especially applicable in windy places, or in localities where the wet season is not usually sufficiently well marked to ensure the spread of the fungi, is to allow the trees attacked by scale insects to become covered with a fairly thick growth of Bengal beans (*Mucuna pruriens*, var.). This method is particularly applicable to lime trees. It has been definitely proved, in Montserrat, that the covering of beans helps to clear the trees of scale insects ; evidence too, from other places, tends to support this, and to show that some fungi, at any rate, are more numerous in the damp sheltered conditions under the beans than is the case outside. It is possible that some other factor or factors due to the beans, which are as yet undetermined, also weaken the scale insect attack. It may be of interest to note in passing, that the Bengal beans encourage the presence of insect parasites of the scales as well as of the fungoid parasites, as they afford shelter from the wind.

BENGAL BEANS[25].

As the use of the Bengal bean in connexion with lime cultivation is restricted as far as the author is aware, to the West Indies, and even there, is limited mainly to the island of Montserrat, some account of it may not be out of place here. The Bengal bean (*Mucuna pruriens*, var.) is closely related to the velvet bean (*Mucuna pruriens*, var. *utilis*), and to the 'cow itch' (*Mucuna pruriens*). The plant was first used in Montserrat purely as a green dressing, and it was in that island that the Hon. F. Driver, the manager of the Montserrat Lime Company's estates, accidentally discovered its useful effects in ridding lime trees of scale insects. The discovery was made about twelve years ago. The bean was used as a green dressing on a field of lime trees which was so badly attacked with scale insects that it was intended to remove the trees when the beans had died down, and replant it with young trees, for which the beans were intended as a manure. It was however discovered, that under the thick covering of beans the trees had considerably recovered from the scale insect attack, and had yielded a very fair crop of limes. In the previous year, practically no fruit had been obtained owing to the effects of the scale insect attack on the trees. Subsequent experience has shown that covering the trees with Bengal beans, in this way, always improves the health of the trees and reduces the number of scale insects on them.

In Montserrat, the beans are planted, four or five around each tree, at the commencement of the rains in May or June; they are allowed to grow until the beans are ripe in the following February or March, when the stems are cutlassed near the ground, and any portions of the vine hanging free from the tree are removed. The mass of vines, however, on the top of the tree is not disturbed. The trees frequently put out strong, vigorous shoots, 6 or 8 feet long, once the beans have been cutlassed, and show general improvement in health, and freedom from scale insects. This improvement appears to be more or less permanent. One field treated in this way, seven years ago, still showed strong, healthy trees in May 1909, though the trees had not been treated in any way whatever in the interval. While the trees undoubtedly benefit in general health, it is also well recognized that the size of the crop from trees covered in beans is reduced when compared with that from healthy trees not so covered, and further, on heavy soils or in wet districts, it seems possible that too thick a covering may be injurious to the lime trees, though under more normal conditions, it is usually found that the thicker the covering, the better is the effect on the tree. The injurious effect on wet soils might be overcome by watching the trees carefully, and if it appeared that the beans were having an ill effect, half of them might be cutlassed off near the ground and the remainder permitted to grow. In this way the covering would be considerably reduced in size, and probably the result would be favourable to the trees. It is hoped that further experiments in this direction may be shortly undertaken. It will also be remarked that the beans afford their maximum shelter to the trees during the wet season. Owing to the nature of the bean, it is at present impossible to form a covering to the lime trees during the dry season. It is, however, possible that by breeding from beans perpetually planted at or near the beginning of the dry season, the natural rhythm of the plant might be altered so that a strain might be produced which would give its maximum growth during part, at any rate, of the dry season. Experiments on the effects of such a bean when grown over lime trees might tend to throw some light on the way in which the beans improve the limes; for it seems that they probably have some effect other than the two already known, namely the addition of nitrogen to the soil, and the protection afforded to parasites of the scale insects.

Experiments are now being carried out with these beans in several of the other islands, and it is hoped that they may be attended with success equal to that experienced in Montserrat. In any case, it is fairly clear that much interesting, and probably important, information with regard to the effects of these plants, more especially the cause of these effects, may still be looked for as a result of systematic experiments and observations; and that, speaking in general, their use in lime cultivation may still be said to be in its infancy.

POSSIBLE RELATION BETWEEN HOST AND PARASITE.

When looking for parasitic fungi, with the possible exception of the black fungus (*Myriangium Duriaei*), it must be remembered that the fructifications, by which alone they are made easily visible, cannot be expected to be present in any given locality at all times of the year. They come and go according to the stage in its life-history that the fungus has reached at the time. As an illustration of this, the following observations in Dominica during 1909 may be cited. The fructifications of the red-headed fungus (*Sphaerostilbe coccophila*) were observed at the Agricultural School in May, but had disappeared at the beginning of June; they did not re-appear until November. These facts should be considered in connexion with the following observations made in Montserrat.

One field was visited by Mr. H. A. Ballou, the Entomologist to this Department, and by the author on March 9, 1910. The field had suffered from attack by the purple scale (*Mytilaspis citricola*) during the preceding twelve months, and had been put under Bengal beans which had been cutlassed a month previously. The trees had recovered from the scale insect attack, but practically no red-headed fungus was observable, although it had been seen a month before in large quantities by two reliable observers. On the next field to leeward, however, fructifications of this fungus, both conidial and perithecial, were present in large numbers. The attack of the insects had reached this field somewhat later than the previous one, as the insects travelled with the wind, and consequently the fungus was still visible, as it also had started its life-cycle at a somewhat later date than in the first field. The presence of the perithecia, which probably constitutes the last stage in the life-history, would appear to indicate that the fungus was about to disappear from the second field also. Both of the instances just cited tend to show that the fungus has a definite life-period which must be influenced to some extent by the amount of food-supply available. It should also be borne in mind that the scale insects themselves have a definite life-period, though details with regard to this are at present wanting in the West Indies. It is probable that the season of greatest abundance of these insects falls between approximately the same dates each year, and the same would also be true of the season of least abundance. The sequence of events would appear to be somewhat as follows. The spores of the fungus are blown on to a tree where numerous young scale insects are present; they germinate if the conditions are not too dry; the germ tubes penetrate the bodies of some of the young scales by growing in under the scale itself, and once established, the fungus spreads rapidly. After very vigorous vegetative growth, during which the only sign of the existence of the fungus is the number of dead insects present, the food-supply becomes exhausted, and the fungus produces fructifications and is then visible. Finally, the fructifications and most of the dead scales are washed off the tree by rain and disappear, leaving the tree clean with the exception of spores of the fungus caught in the bark, a small residue of dead scales that have not been removed, and a few healthy scales that have not been infected by the fungus. If the scale insects reinfect the tree, either owing to the increase of the original survivors, or to infection from an outside source, the spores germinate again, or reinfection takes place from outside, and, as the scales become fairly numerous, the life-story of host and parasite is repeated. There are thus probably two periods when the fungus is not visible : one when it is making much vegetative growth, scale insects being numerous, the other when it has disappeared owing to the absence of a sufficient food-supply ; under the latter circumstance, very little fungus is present at all on the tree. How far the life-period of the fungus is affected by external conditions remains to be seen ; probably moisture has an effect on the rate of growth during the period of vegetative activity. The relationship of the fungus life-period to that of the host also requires investigation, but for this, the life-period of the scale insects, that is the time occupied from one brood to the next, must first be carefully determined. In any case, it seems that the food-supply, as afforded by the insects, cannot be expected to be entirely continuous. Green[14], in his book on the *Coccidae of Ceylon*, remarks on the periodicity of the appearance of the green shield scale (*Lecanium viride*), and says that this is apparently connected with weather conditions, extremes of rain or of drought being alike unfavourable. Moreover, when the numbers of live scales are decreasing, the shield scale fungus is always found to be present and may kill as many as 90 per cent. of these insects.

The above suggestions are put forward in a purely tentative manner, as the evidence on which they are based is insufficient to permit of any definite conclusions. They may, however, be useful as suggesting lines of work for future investigation. The matter is one of some importance locally, as fructifications are often wanted for purposes of spreading the fungus, and, as has been noted, they cannot always be found. When this is due to the greater vegetative activity of the fungus, it might be spread with equal effect by using branches of trees on which fructifications of the fungus had formerly been observed, but from which they had subsequently disappeared. The mycelium of the fungus would then be present. But when the absence of the fructifications is due to the disappearance of the fungus owing to want of food, such material would be nearly useless for infection purposes. In this case the scale insects themselves would probably be far from numerous, and those present would be mainly dead, unless the tree had been reinfected with insects while the fungus had not had time to obtain a hold.

EFFECTS OF CLIMATE.

The general climatic factors which may have an influence on the effectiveness of these fungi are three; namely, temperature, wind and moisture.

TEMPERATURE. The four species of fungi known in the West Indies all belong naturally to the tropical or subtropical regions, and consequently cannot be expected to flourish in colder parts of the world. This expectation has been fully borne out in the case of the red-headed fungus (*Sphaerostilbe coccophila*). Several attempts have been made to introduce it into the more northern of the United States and into Canada, but it has never been sufficiently vigorous under the colder conditions to be of any economic importance in controlling insect pests.

WIND. Parasitic fungi are never so effective in windy situations as in sheltered ones. In fact, they are rarely found in places where they are exposed to any severe winds. This is probably mainly due to the drying effects of the wind. The shield scale fungus (*Cephalosporium lecanii*) has been found by Mrs. Patterson in St. Vincent attacking the mango shield scale (*Lecanuim mangiferae*), which was growing on a tree in a very windy place, but the fungus was not of luxuriant growth and did not appear to be nearly as effective as it is in calmer places.

MOISTURE. This is the most important factor influencing the growth of these fungi—a fact which is clearly illustrated by the relative effectiveness of the fungi in the different islands The parasites are very plentiful in Dominica, where the rainfall varies on some estates from 100 to 150 inches in a year, and in St. Lucia, where there is almost as heavy a rainfall, at any rate in some districts. As already stated, since the year 1903, there has not been a single outbreak of scale insects of any really serious dimensions in Dominica. Dr. E. W. Berger[4] remarks that under natural conditions, fungi were able to control the attacks of white fly once every three years. It would seem, however, that in Dominica, the scale insects are kept in check much more effectively than this. On the other hand, in Antigua and Barbados, and possibly even St. Vincent, they are not nearly as effective. In the former cases, this is probably owing to drought; in the latter, the causes would appear to be more complicated, as the island is not excessively deficient in rainfall. In fact, at one time citrus trees could be grown there with success, though now, more especially since the eruption in 1902, they are persistently destroyed by the attacks of scale insects. The actual reasons for this require further investigation, as at least three species of parasitic fungi are known to be present on scale insects in the island.

A good instance of the effect of drought is furnished by the outbreak of scale insects in Montserrat and Dominica already referred to, which took place in 1903. It was found that while both the white and purple scales (*Chionaspis citri* and *Mytilaspis citricola*) were present in both islands, the greater part of the damage in Montserrat was due to the white scale (*Chionaspis citri*), while in Dominica, which even in a dry season is damper, the purple scale (*Mytilaspis citricola*) was more serious. It has since been found that, under normal conditions, the black fungus (*Myriangium Duriaei*) acts as an efficient check on the white scale in both islands, while observations show that in Montserrat, this scale never becomes serious unless the tree is suffering from drought. This would appear to indicate that, in 1903, the drought in Montserrat was so severe as to check the black fungus and thus enable the white scale to become numerous. In Dominica, the drought was not so severe as completely to check this fungus, though the more delicate red-, and white-headed fungus parasites of the purple scale (*Sphaerostilbe coccophila* and *Ophionectria coccicola*) were rendered ineffective. These observations would appear, then, to bring out two points. Firstly, the effect of drought on the fungi, as already indicated; and secondly, the fact that the black fungus is hardier in this respect than the other species. The second of these conclusions, however, must be tested by future observations before it can be definitely accepted, as there are no records of the relative abundance of the fungus in these two islands during the year under consideration.

The outbreak of scale insects in Dominica in 1903 presents some further features of interest in connexion with the effect of external conditions on the parasites of these insects. In 1902, the season was dry, the yield of fruit from the lime trees, which were those principally attacked, was very heavy, and the island was covered with dust from the eruption of Mont Pelée. During the ensuing dry season at the beginning of 1903, the trees were badly attacked by scale insects, which, however, rapidly disappeared again in the subsequent normal years 1904 and 1905. It is of course clear that the trees had been weakened by the heavy crops, combined with the general unfavourable conditions in 1902; but it is also fairly certain that the spread of the scale insects was largely due either to the absence of the parasites by which they had formerly been controlled, or at any rate to the check that the parasites had received through want of moisture, together with the effects of the volcanic ash, in 1902, and the succeeding dry season in 1903.

The idea that the reduction of the parasites was the factor mainly responsible for the outbreak of this scale insect attack is supported by the gradual return to the normal conditions which occurred during the years 1904 and 1905, and by the absence of any serious subsequent attacks. Moreover, the outbreaks cannot be explained as due to the introduction of new species of scale insects, as the scales concerned, mainly the purple and the white scales (*Mytilaspis citricola* and *Chionaspis citri*) were both reported by Professor Riley as being present in the island in 1894. It should also be mentioned, that on some estates extensive spraying operations were carried on chiefly with kerosene emulsion and rosin compound. The trees on such estates recovered much more quickly than those which were not treated, and it seems likely that, in certain cases at any rate, the complete loss of many trees was prevented. It should be noted, further, that the solutions used were those least likely to have any harmful effect on parasitic fungi of the scales, and that they probably were of actual assistance by checking those insects sufficiently, to enable the parasites to regain their former supremacy.

As the effect of volcanic ash has been mentioned, it may be worthy of record, that there seems to be a fairly general belief among planters throughout the islands, to the effect that black blight, and therefore probably scale insects, have been more common since the big eruptions in Martinique and St. Vincent in 1902. This may possibly be due to the effect of the ash on the parasites of the scales. While it might be so in the case of the delicate insect parasites, it is not an easy matter to account for the effect on the fungi. In any case, this would seem to be an illustration of the great increase in numbers of an insect, owing to the fact that the natural control exerted by its parasites had been removed, or seriously checked. The scale insects may themselves have been greatly reduced in numbers, but the much larger destruction of the more fragile parasites provided an opportunity for their almost unrestrained natural increase. As there is little doubt that the survival of the parasites occurred to some extent, it is fairly certain that they will ultimately reach such numbers as to be capable of exerting the same control as existed before the volcanic eruptions.

THE EFFECT OF SCALE INSECT PARASITES ON THE PRESENCE OF BLACK BLIGHT.

As a result of enquiries made in all the islands, it has been shown fairly definitely, that black blight fungi (*Capnodium* and *Meliola* sp.), but especially *Capnodium mangiferae*, are never found on trees where they are not in some way or other associated with the presence of one or more species of scale insects. The commonest insects in this connexion are the green scale (*Lecanium viride*), and the mango shield scale (*L. mangiferae*). Consequently, the reduction of the scale insects by means of their parasites should be attended by a lessening of the amount of black blight, and where a tree is successfully cleared of insects, the blight should also disappear. Experiments with a view to controlling black blight in this way have been suggested for trial in Grenada—an island in which there is a very large amount of this disease. On the other hand, the author has seen a species of black blight fungus on a palm at the Botanic Station at St. Lucia, distributed in such a way under the inflorescences as to lead to the suspicion that the fungus was living on the nectar falling upon the leaves from the flowers. This idea was supported by the fact that there were very few scale insects present on the leaves. Mr. Moore the Agricultural Superintendent in St. Lucia, who first observed this, suggested that possibly, the same thing was true in the case of the mango, and if so, removal of the scale insects would not have the effect of removing the blight until after the flowering season in the case of the trees mentioned. These points, however, all require further investigation, and at any rate, the question of the prevention of black blight is somewhat of a side issue.

COMPARISON OF ARTIFICIAL AND NATURAL METHODS OF CONTROLLING SCALE INSECTS.

Before proceeding to the next division of the subject, it may be advisable to add that Hume[15] in his book on *Citrus Fruits and their Culture*, remarks that the effect of attempting to combine the artificial control of scale insects (by means of various sprays and by fumigation) with the natural control (by means of parasites), only results in producing the bad effects of both methods ; and it seems at present that the natural means of control is undoubtedly the one most suited to the conditions in the majority of the West Indian Islands. The reasons for this are of two kinds. In the first place, the natural method of control is not so expensive to institute as the artificial method, involving as it does no outlay on spraying pumps and materials, and but comparatively little labour. Further, it does not necessitate periodically recurring outlays for the repetition of the treatment, since once established, the only cost involved, that of reintroducing the parasites where this is necessary by means of one of the methods already described, and of replanting Bengal beans (*Mucuna pruriens*, var.) in places where their use is advisable, is of very minor importance when compared with the expense incurred in extensive spraying operations, which may have to be repeated two or three times in a year. In the case of limes, moreover, the value of the crop is small compared with that of the more specialized forms of citrus fruits such as oranges, so that it does not permit expensive spraying operations to be conducted with profit. Cost is an even more important factor in the case of field fumigation on account of the heavy outlay involved in buying tents. Secondly, on many estates in the West Indies, the nature of the ground, its roughness and slope, difficulties of obtaining water, of procuring sufficiently skilled labour, and similar factors render spraying on a large scale impossible from a practical point of view. These same factors, more especially that of obtaining sufficiently skilled labour, also prevent, to an even greater extent, the use of fumigation.

Experience in Montserrat, where the scale insects are always liable to cause serious trouble, has shown that with a little assistance, more especially in dry seasons, the natural enemies are just able to keep the insects in check. Recent investigations by the Entomologist of the Department, Mr. H. A. Ballou, and by the author have shown that numerous parasitic species of both insects and fungi are present, and possibly the control effect is due more to the number of species than to the number of individuals of those species. Mr. Driver and his colleagues are of the opinion that spraying methods are not of much use ; and moreover, trees examined showed clearly, that where sprays had been employed, the natural enemies of the scales had received a decided check. This was well illustrated in one particular case. In a certain field a belt of trees had been sprayed about twelve months before they were examined, while the remainder were left unsprayed. On the unsprayed portion, the red-headed fungus (*Sphaerostilbe coccophila*) was abundant on the white and purple scales (*Chionaspis citri* and *Mytilaspis citricola*), but on the sprayed portion only a few fructifications were found. This observation certainly supports the statement by Hume referred to above.

The following is a short abstract of a letter written by Mr. P. Foster Huggins to the St. Vincent *Sentry* of April 8, 1910, that contains some points of interest in this connexion:—

The frequent appearance of black blight in St. Vincent is associated with scale insects which infest either the plants which exhibit the blight, or overhanging trees. The author found that individual effort to control the scales by artificial means was useless, as, even when the trees were cleared, they rapidly became reinfested from surrounding vegetation on which the scales abounded. He lost hundreds of grown orange and other trees owing to the prevalence of the scales, but recently, some of the remaining trees have shown signs of improvement. This has been due to the presence of a small red fungus on the scales (undoubtedly *Sphaerostilbe coccophila*), which attacked the mussel scale (*Mytilaspis citricola*), the white scale (*Chionaspis citri*), and the red scale (*Aspidiotus* sp.), though the star scale (*Vinsonia stellifera*) was unaffected. Experiments in transferring the fungus from tree to tree were successful whenever the weather was wet, and the author now has hopes, not only of keeping his trees alive, but of getting them into a good condition for cropping.*

On the other hand, under exceptional circumstances, such as a serious epidemic of scale insects in a dry season, it is probable that the judicious use of insecticides such as whale-oil soap compound, kerosene emulsion, or rosin compound would prove of the utmost value. Not only would such spraying mixtures prevent the immediate infliction of excessive damage on the trees, but they would, as already pointed out, enable the natural enemies to regain their position in a shorter time. Dr. Berger in a short article 'Citrus scales and White fly' contained in the *Florida Agriculturist* for March, 1910, supports this view but insists on the avoidance for this purpose of any insecticides containing sulphur or possessing any fungicidal ingredients.

When considering this point it must, however, be borne in mind that, in addition to the four species of fungi, there are also several species of insects which live on scale insects. Among these is a small hymenopterous species which lives as an internal parasite on the purple scale (*Mytilaspis citricola*). Such delicate insects, and especially that just referred to, would almost certainly be destroyed by insecticides, and the proportion of them thus killed would be even greater than that of their hosts. Thus it would probably be found after employing insecticides, that parasitism by these insects would not be as common as before. As a result of these arguments it will be evident that, even in serious cases, insecticides should only be used as a last resource, once it has been determined that the natural means of control is that most suited to ordinary conditions

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*[The scientific names in brackets have been inserted by us. Ed. *W. I. B.*]

PART II.

DISTRIBUTION OF THE FUNGI AMONG THE ISLANDS.

In this part of the paper, an attempt will be made to give some account of the distribution of the different species of fungi, and of the different scale insects which they attack, throughout the islands of the Lesser Antilles. In Table I, a list is given in chronological order, of the records of the occurrence of these parasites as shown by files at the Head Office of this Department, for the years previous to April 1909. Table II shows the parasites recorded in each island since April 1909, the scales on which they occur and the plants attacked by the scales in each instance, together with the date on which the observation was made; a summarized list of the insects attacked by each fungus and a list of the islands in which they occur, are also given. Other records of the presence of parasitic fungi of this nature in Cuba, Porto Rico, Jamaica and the West Indies in general, occur in the following publications: Cook and Horne, 'Insects and Orange Diseases', *Bulletin 9*, Cuba Experiment Station. J. Parkin, 'Fungi Parasitic upon Scale Insects', *Annals of the Royal Botanic Gardens*, Peradeniya, Vol. III, part 1. F. S. Earle, *Annual Report, Porto Rico Experiment Station*, 1903, and *Primer Informe de la Estacion Central Agronomica de Cuba.* Cockerell, *Bulletin of the Botanical Department*, Jamaica, No. 36, 1892, and *Institute of Jamaica Lectures, Agriculture*; *Special Publications of the Institute of Jamaica*, No. 3, 1893. *Bulletin of the Institute of Jamaica*, Vol. I, No. 4., p. 137.

A full account of the distribution of the red-headed fungus is contained in a paper 'Fungi Parasitic upon Aleyrodes Citri' by H. A. Fawcett.

As will be seen, the names of many of the fungi are followed by a mark of interrogation. This is due to the fact that while the records show the presence of a fungus, so little attention was given to the subject at the time, that the species, with the exception of *Sphaerostilbe coccophila*, were unidentified, though by the aid of specimens preserved in the Laboratory at the Head Office, it has since been possible to identify *Ophionectria coccicola* in Dominica, in one or two instances. Consequently, the identity of the fungus in these cases is a matter of speculation based on the information and somewhat meagre descriptions contained in the record, on the recollections of officers of the Department, and to some extent also, on the nature of the scale attacked. As a result, the identifications cannot be taken as entirely reliable, though every care has been exercised to render the account as accurate as possible.

The paucity of the earlier records is due to two facts. In the first place, the conditions were such that no special attention could be given to the subject; and in the second, such observations as were made tended to indicate that these fungi did not possess much economic value.

TABLE I.

Date.	Fungus.	Place.	Scale.	Host plant.	Observer.
1892.	*Cephalosporium lecanii* ?	Montserrat	*Lecanium hemisphaericum*	Coffee	C. A. Barber[3]
Mar. 12, 1894	*Cephalosporium lecanii* ?	Dominica	*Lecanium hemisphaericum*	...	Prof C. V. Riley
Nov. 7, 1900.	*Sphaerostilbe coccophila*	Trinidad	*Mytilaspis citricola*	Orange	J. H. Hart
1900.	*Cephalosporium lecanii* ?	Barbados	*Lecanium mangiferae* and *Lecanium hemisphaericum*	Bread-fruit, Coffee, etc.	H. M. Lefroy H. M. Lefroy
Jan. 15, 1902.	*Sphaerostilbe coccophila*	Trinidad	.	..	J. H. Hart
Jan. 20, 1902.	*Sphaerostilbe coccophila*	Dominica St. Lucia	. .	. .	A. Howard
Feb. 26, 1902.	*Cephalosporium lecanii* ?	Antigua	*Lecanium hemisphaericum*	.	W. N. Sands
Jan. 15, 1903.	*Sphaerostilbe coccophila*	Dominica	*Mytilaspis citricola*	Lime	L. Lewton-Brain
Feb. 2, 1903.	*Sphaerostilbe coccophila*	Dominica ?	*Mytilaspis citricola* and *Aspidiotus articulatus*	Sweet Orange	H. M. Lefroy
Mar. to April 1903.	*Cephalosporium lecanii* !	Antigua	*Lecanium hemisphaericum*	*Eranthemum* sp. & mango	H. A. Ballou[1]
April 1903.	*Sphaerostilbe coccophila* and *Ophionectria coccicola*	Dominica	*Mytilaspis citricola* and *Chionaspis citri*	Limes	H. A. Ballou[2]
Dec. 1903	*Sphaerostilbe coccophila*	Dominica	*Mytilaspis citricola* and *Chionaspis citri*	Limes	H. A. Ballou
Sep. 20, 1904.	*Sphaerostilbe coccophila*	St Lucia	...	Rose	L Lewton-Brain
Jan. 22, 1906.	*Ophionectria coccicola*	Dominica	*Mytilaspis citricola*	Limes	H. A. Ballou[26]
May 1906.	*Ophionectria coccicola*	Dominica	*Mytilaspis citricola*	Limes	H A. Ballou
Sept.-Oct. 1907.	*Sphaerostilbe coccophila* *Cephalosporium lecanii* ?	Dominica Dominica	*Mytilaspis citricola* and *Lecanium viride*	...	F. A Stockdale

TABLE II.

Island.	Fungus.	Date.	Insect attacked.	Host plant.
Barbados	*Cephalosporium lecanii*	Aug. 12, 1909	*Lecanium hesperidum*	*Ixora* sp.
		Aug. 24, 1909	*Lecanium hemisphaericum*	*Eranthemum* sp.
		Sept. 17, 1909	*Lecanium nigrum*	Hibiscus
		May 20, 1910	*Lecanium mangiferae*	Mango
	Myriangium Duriae	Sept. 8, 1909	*Chionaspis citri*	Lime
Grenada	*Cephalosporium lecanii*	Aug. 26, 1909	*Lecanium mangiferae*	Mango
		Aug. 26, 1909.	*Lecanium hesperidum*	Orange
		March 18, 1910	*Lecanium mangiferae*	Mango
	Sphaerostilbe coccophila	May 29, 1909	Scales indeterminable	Sapodilla
		July 24, 1909	*Ischnaspis filiformis*	*Ficus* sp.
		May 1910	*Mytilaspis citricola*	*Citrus* sp.
		Uncertain	*Ischnaspis filiformis*	Not recorded
St. Vincent	*Cephalosporium lecanii*	Aug. 13, 1909	*Lecanium mangiferae*	Mango
		Dec. 1, 1909	*Aphis gossypii*	Melon
		May 3, 1910	*Lecanium viride*	Liberian coffee
	Myriangium Duriaei	Oct. 5, 1909	*Chionaspis citri*	Lime
	Sphaerostilbe coccophila	Nov 2, 1909	*Chionaspis citri* *Mytilaspis citricola*	Lime
		April 8, 1910	*Aspidiotus* sp. *Mytilaspis citricola* *Chionaspis citri*	Orange
St. Lucia	*Myriangium Duriaei*	Aug. 13, 1909	*Chionaspis citri*	Lime
	Sphaerostilbe coccophila	July 26, 1909	*Mytilaspis citricola*	Lime

TABLE II.—(*Continued.*)

Island.	Fungus.	Date.	Insect attacked.	Host plant.
St. Lucia	*Sphaerostilbe coccophila*	Feb. 15, 1910	*Aspidiotus* sp. *Asterolecanium pustulans* *Diaspis* sp. *Lecanium oleae* *Dactylopius* sp.	Castilloa
		April 1, 1910	Same scales	Castilloa
Dominica	*Cephalosporium lecanii*	Nov. 1, 1909	*Lecanium viride*	Lime
		Dec. 6, 1909	*Lecanium* s p. probably *viride*	Lime
		Jan. 8, 1910	*Lecanium* sp. probably *viride*	Lime
		Jan. 21, 1910	*Lecanium* sp. probably *viride*	Lime
		Jan. 21, 1910	*Lecanium mangiferae*	Mango
		May 11, 1910	*Lecanium mangiferae* *Lecanium viride*	Mango not identified
	Myriangium Duriaei	Dec. 14, 1909.	*Chionaspis citri* *Mytilaspis citricola*	Lime
		Dec. 28, 1909	*Mytilaspis citricola*	Lime
	Ophionectria coccicola	Dec. 6, 1909	*Mytilaspis citricola*	Lime
		Dec. 14, 1909	*Mytilaspis citricola* *Chionaspis citri*	Orange
		Dec. 28, 1909	*Mytilaspis citricola*	Lime
		Jan. 8, 1910	*Mytilaspis citricola*	Lime
		Jan. 21, 1910	*Mytilaspis citricola*	Lime
	Sphaerostilbe coccophila	June 10, 1909	Not recorded	Not recorded
		Dec. 6, 1909	*Mytilaspis citricola*	Lime
		Dec. 28, 1909	*Ischnaspis filiformis*	*Raphia vinifera*
		Jan. 21, 1910	*Mytilaspis citricola*	Lime

TABLE II.—(*Concluded.*)

Island.	Fungus.	Date.	Insect attacked.	Host plant.
Montserrat	*Cephalosporium lecanii*	March 13, 1910	*Lecanium hemisphaericum*	*Eranthemum* sp.
		April 2, 1910	*Lecanium mangiferae*	Mango
		April 9, 1910	*Lecanium viride*	Clammy Cherry *
	Myriangium Duriaei	Dec. 28, 1909	*Chionaspis citri* *Mytilaspis citricola*	Lime
		March 12, 1910	*Chionaspis citri* *Mytilaspis citricola*	Lime
		March 26, 1910	*Chionaspis citri*	Lime
		May 14, 1910	*Chionaspis biclavis*	Croton
	Sphaerostilbe coccophila	Feb. 22, 1910	*Mytilaspis citricola* *Chionaspis citri*	Lime
		March 12, 1910	*Mytilaspis citricola* *Chionaspis citri*	Lime
		April 2, 1910	*Mytilaspis citricola* *Chionaspis citri*	Lime
Antigua	*Cephalosporium lecanii*	Sept. 28, 1909	*Lecanium oleae*	Bastard Cedar†
	Sphaerostilbe coccophila	Dec. 24, 1909	*Lecanium oleae*	Soap Berry††
		Dec. 24, 1909	*Lecanium viride* *Mytilaspis citricola*	Lime
		Dec. 24, 1909	*Aspidiotus articulatus* *Chionaspis citri* *Mytilaspis citricola*	Lemon
		March 23, 1910	*Asterolecanium pustulans*	Castilloa

**Cordia Colococca.* †*Guazuma tomentosa.*

Cephalosporium lecanii has been reported from :—

Barbados, St. Vincent, Grenada, Dominica, Montserrat, Antigua.

Myriangium Duriaei has been reported from :—

Barbados, St. Vincent, St. Lucia, Dominica, Montserrat.

Ophionectria coccicola has been reported from Dominica, only.

Sphaerostilbe coccophila has been reported from :—

St. Vincent, Grenada, St. Lucia, Dominica, Montserrat, Antigua.

Cephalosporium lecanii has been found on the following insects :—

Aphis gossypii, *Lecanium hemisphaericum*, *L. hesperidum*, *L mangiferae*, *L. nigrum*, *L. oleae*, *L. viride*.

Myriangium Duriaei has been found on *Chionaspis citri*, *C. biclavis*, and *Mytilaspis citricola*.

Ophionectria coccicola has been found on *Mytilaspis citricola*.

Sphaerostilbe coccophila has been found on the following insects :—

Aspidiotus articulatus, *Aspidiotus* sp., *Asterolecanium pustulans*, *Chionaspis citri*, *Dactylopius citri* (?), *Diaspis* sp. (?), *Ischnaspis filiformis*, *Lecanium oleae*, *L. viride* (?) and *Mytilaspis citricola*.

From general considerations, it seems probable that *Sphaerostilbe coccophila* will be found to occur in Barbados, and *Myriangium Duriaei* in Grenada and Antigua, as the evidence shows that these fungi are native to the western hemisphere, and the first is almost universal throughout the West Indies. No records of their occurrence, however, exist up to the present. Two other facts in connexion with these tables are worthy of notice. Firstly, as has been previously stated, though three of the fungi occur in St. Vincent, none of them seem to be widely efficient, although the circumstances are reasonably favourable. Secondly, *Cephalosporium lecanii* does not appear to attack *Lecanium viride* on limes in Montserrat. This is peculiar, as this insect is very common on lime trees, and strong growths of the fungus have been recorded on *L. mangiferae* and *L. hemisphaericum*, as well as *Lecanium viride* attacking clammy cherry (*Cordia Collococca*). It is hoped that experiments, with a view to infecting *Lecanium viride* on limes, will soon be undertaken. A possible explanation of the limitation of *Ophionectria coccicola* to Dominica will be put forward in the last part of the article. The fungus is a most efficient and vigorous parasite on the principal citrus scales.

As will be seen, the record is most complete for Dominica, where nearly all the fungi have been found, in situations ranging from the coast level to a height of 2,000 feet, and with a yearly rainfall varying from 60 inches near the coast, to 200 inches in the mountains. After Dominica, Montserrat shows the most complete records, though they are mostly of recent date. The explanation of this will be seen by referring to the column containing the list of host plants; the principal crop in both these islands is that of limes, whereas in the other islands the crops are either sugar, cacao, or cotton. Of the plants mentioned, the lime is perhaps that most subject to scale insect attack, and the conditions on a lime plantation are such as to afford the greatest encouragement to the fungi. Cacao is practically free from attack by scale insects, while sugar is but slightly affected. The snow scale and the black scale (*Chionaspis minor* and *Lecanium nigrum*) both attack cotton, but they are frequently kept well in check by insect parasites. The question is thus, naturally, one of more importance in lime-growing islands than in any others, with the possible exception of Grenada, where the very general occurrence of black blight accompanied by the soft shield scales (*Lecanium* spp.) makes the encouragement of their parasites worthy of special attention. Further, the record for St. Lucia shows the importance of the red-headed fungus (*Sphaerostilbe coccophila*) in places where an attempt is being made to cultivate Castilloa trees. This tree is always subject to the attacks of numerous scale insects, of which the red-headed fungus is, under favourable conditions, a most efficient parasite.

The dates of the observations have been recorded in Table II, so as to render available some account of the months in which the fructifications of the fungi are most common. This will serve as a basis for investigations to determine if there is any seasonal periodicity in their appearance.

PART III.

DESCRIPTION OF THE FOUR SPECIES OF FUNGI.

Cephalosporium lecanii, Zimmermann. This fungus was first described by Zimmermann[23] from Java, but a much fuller account of it is given by Parkin in Vol. III, Part 1, of the *Annals of the Royal Botanic Gardens*, Peradeniya. His account agrees with that of the specimens found here, and is, consequently, quoted in full. The writer was enabled to obtain this description owing to the courtesy of Dr. H. T. Fernald, of the Agricultural Experiment Station, Massachusetts, who caused it to be copied out and forwarded to this Department. Parkin's account is as follows:—

'As was pointed out in the introduction to this paper, Zimmermann[23] named a fungus which he found attacking the green bug (*Lecanium viride*) on the coffee in Java, *Cephalosporium lecanii*.

'The short account he wrote about it was intended more for the benefit of the Java planters than as a botanical treatise. Beyond this pamphlet I have come across no further allusion to such a type of fungus in connexion with scale insects.

'In Ceylon, a fungus similar to this Java one has been observed repeatedly by Mr. Green and myself on species of Lecanium. In fact, he has been aware of it in the island for some years on the green bug. To particularize, four separate lots have been collected on *L. viride*, three lots on *L. hemisphaericum*, and two on *L. nigrum*.

'The fungus shows itself to the naked eye as a white or pale-yellow powdery bloom around, and to some extent over, the scales. The powdery or mealy appearance is due to innumerable conidial heads covering the hyphae. The external part of the fungus develops as follows: Hyphae radiate out on all sides from below the scale for a millimetre or more over the leaf surface. Each hypha produces at frequent intervals short lateral branches, the conidiophores, 16-20 *Microns* in length. Each conidiophore bears on its apex a spherical head of conidia, enveloped in mucilage. This head, with a diameter of 4 *Microns*, appears when dry as a glistening globule, the individual conidia not being distinguishable. On treatment with water the mucilaginous matter dissolves and the conidia are dispersed: sometimes the last one produced remains attached to the tip of the hypha. In order to examine the conidia *in situ*, the fungus should be mounted in dilute acetic acid, which prevents the mucilage from dissolving and renders the conidia visible. Five to seven are usually present in one head. They are really abstricted from the conidiophore in succession, but instead of remaining in a chain, become aggregated together into a spherical mass by the mucilage which is secreted. Some infected scales kept in a damp atmosphere showed conidiophores bearing conidia in short curved chains, owing perhaps to the mucilage not being able to mass them together.

'The colourless conidia are minute, measuring 3·5 4 × 1·4 *Microns*, figures almost identical with those given by Zimmermann for the Java form. They are shortly cylindrical, or nearly oval, or slightly saussage-shaped.

'The conidiophores may be so numerous that here and there the mucilaginous heads which touch one another, fuse to form larger masses of conidia.

'The lateral short branches of the main hyphae, which here are termed conidiophores, may even branch themselves, so as to produce two to four heads of conidia.

'If a scale from affected material, but with no external fungus visible, be removed from a leaf and placed on a microscopic slide in a damp chamber, the development of the conidial part outside the insect can be readily followed. After one day the radiating hyphae proceeding from the margin of the scale were just visible, after two days the first conidiophores appeared, and after four to five days the whole insect was surrounded by a fringe of hyphae bearing numerous conidial heads.

'An example of Cephalosporium parasitic on *Lecanium hemisphaericum*, var. *coffea*, on the stem of *Jussiaca suffruticosa* possessed a few perithecia. These were resting on the peripheral part of the fungus, and were globular in shape and pale-yellow in colour. The long asci within, unfortunately, showed no definite spore formation, and so were most likely immature. However, their presence points to the probability of this Cephalosporium being a conidial stage of some genus of the Hypocreales, to which group nearly all the other Ascomycetous scale-fungi described belong.

'Before leaving this genus, a remark is needed upon its systematic position in the Fungi Imperfecti. According to the synopsis given in *Die Pflanzenfamilien*, Cephalosporium is placed in a small group of genera characterized by the conidia *not* being enveloped in mucilage, whereas the neighbouring genus Hyalopus has its conidia so held together. The Ceylon form and the Java one, according to Zimmermann, possess mucilage, so on this classification they should both be referred rather to Hyalopus.'

References to what was probably this fungus occur in several early numbers of the Department publications, and in even earlier records in the West Indies, as for example, Barber[3] in *The Supplement to the Leeward Islands Gazette*, No. XVIII, 1893, and Cockerell[5] in the *Lectures of the Jamaica Institute, Agriculture*, p. 102, already referred to. The specimens which led to its investigation here were found in Barbados, in August 1909, attacking *Lecanium hesperidum* on a species of *Ixora.* Some specimens were sent to Professor Fawcett of the Florida State Experiment Station, who at first thought it was a species of the genus Sporotrichum, but on further examination came to the conclusion that it was probably identical with *Cephalosporium lecanii,* Zimmermann. Green in his *Coccidae of Ceylon* records this fungus as a parasite of *Lecanium viride,* and says that it is very effective. It seems possible that it is the same as that mentioned by Professor Earle[9] as a parasite of *Lecanium hemisphaericum* in Porto Rico, and provisionally referred by him to the genus *Sporotrichum.* This idea is suggested by the short description of the fungus contained in the *Porto Rico Experiment Station Report*, 1903. There is also a possibility that it is the same as the species of *Sporotrichum* mentioned on pages 23, 25 and 27 of *Bulletin 9 of the Estacion Central Agronomica de Cuba*[6]. Watt and Mann[22] also record the presence of a grey fungus on *Lecanium viride* in India. Professor Fawcett records the appearance of what is probably the same fungus on some Lecanium scales at Gainesville, Florida, on a pine tree, and has also informed the Department that it occurs in British Guiana.

Although there does not seem to be much doubt as to the parasitic nature of the fungus, yet it must be stated that inoculation experiments on living insects conducted in Florida by Professor Fawcett have so far proved unsuccessful, and consequently, it must be admitted that the fungus may be only of a secondary nature. Further experiments are necessary to determine this point.

Though there are several previous records of the occurrence in the West Indies, of what was probably the same fungus, the evidence indicates that it is not a native species. Professor Riley in 1894, recorded the occurrence in Dominica of what was probably this fungus on *Lecanium hemisphaericum.* It only occurred in the neighbourhood of the Botanic Station, and this led him to suggest that it had been imported recently. Very similar evidence is forthcoming from Grenada, where even now the fungus is limited to the neighbourhood of the Botanic Station, and occurs chiefly on *Lecanium mangiferae*. It is, however, reported to be spreading. In Montserrat it has been found near an experiment station supplied from the Botanic Station, but does not attack *Lecanium viride* on limes in a general way, though it has been found on this scale on Clammy cherry (*Cordia Collococca*). This suggests again that it is of fairly recent introduction, though it is also possible that *Lecanium viride* is even more recent. There is no evidence at present to suggest the source from which it was originally derived.

Myriangium Duriaei, Mont. and Berk. This fungus in its early stages forms a number of small, black, somewhat spherical stromatal masses, each from ½ to 2 millimetres in diameter, often borne on a very short stalk. Each constitutes a fructification of the fungus. If the scales are very numerous and the fungus has been present for some time, the separate fructifications become crowded together to form a wide-spreading, black crust on the scales, and then it has a rough, irregular surface. Each stromatal mass consists of an outer layer of black, carbonaceous pseudoparenchyma enclosing completely a soft, colourless pseudoparenchyma in which the ascigerous cells occur. These are minute, and irregularly scattered throughout the soft tissue, though they are, on the whole, produced in basipetal succession from the lower part of the colourless pseudoparenchyma. The cavities are more or less subglobose, and each contains a single ascus of approximately the same shape as the cavity. In each ascus, eight hyaline, ovate-oblong, multiseptate, muriform spores are produced. The ascigerous cavities are forced up towards the surface of the stroma, become more or less free owing to the decay of its outer layer, and are finally extruded owing to the pressure of their inner membrane.

The following diagnosis is given by Ellis and Everhart[11]:—

'Stromata in densely crowded patches or clusters ½ to 1 cm. across, the single stromata ½ to 1 mm. in diameter, black, plane or convex above, suborbicular or angular from crowding. Ascigerous cells minute, scattered irregularly but abundantly through the substance of the stroma, obovate or subglobose, each containing a single ascus. Asci globose, obovate or pyriform, 50-80 *Microns* in the longer diameter and about 40 *Microns* in the shorter, 8-spored, without paraphyses. Sporidia ovate oblong, hyaline, 5-7 septate, with one or more partial longitudinal septa, rounded and obtuse at the ends, 20-30 × 12-15 *Microns*, mostly a little constricted at the middle septum and slightly curved.

'The measurements of asci and sporidia are from the Florida specimens; those from more northern localities have the sporidia mostly smaller. The Florida specimens also differ from those found in the northern States, in the absence of any free-margined thalloid, effigurate subiculum.'

The West Indian form seems to agree with the Florida specimens in type, and may have originally come from there.

Another description, as follows, is given by Zimmermann[24] in a paper on Javanese Ascomycetes parasitic on Coccidae:—

'The fungus forms a black pseudoparenchymatous stroma, beneath and upon the surface of the scale insect *Ischnaspis filiformis*, which only spreads a short distance beyond the edge of the insect. On the surface of this stroma are formed pseudoparenchymatous protuberances in which the asci are contained; these become free by the crumbling of the superficial layers. They are ovate, 35 *Microns* in length, 8-spored, with a mucilaginous inner membrane. The colourless spores are muriform, many-celled, 25 x 10 *Microns*. and constricted in the middle.

'On *Ischnaspis filiformis*, Dongl., on the leaves of *Coffea Liberica* and *Elaeis* spp., Buitenzorg. The fungus, nevertheless, is not subject to the presence of the insects; it probably only penetrates into the scales of dead insects.'

It is worthy of note that when first described, this fungus was thought to be a saprophyte on decaying wood, or even in some cases a potential parasite on trees. The scale insects on which it grows were entirely overlooked.

The fungus grows more slowly than the other forms, but is no less effective in the end, that is, so far as observations in the West Indies go; and probably is more resistant to drought. It is reported by Cook and Horne[8] as occurring on *Chionaspis citri* in Cuba, and by Earle[10] on *Mytilaspis citricola* in the same island. The same observer[9] also found it on the purple scale in Porto Rico. Rolfs and Fawcett[19] report its occurrence on *Mytilaspis Gloveri* and *M. citricola* in Florida. Zimmermann[24] on *Ischnaspis filiformis* in Java. Parkin[18] also records it on the same scale in Java, and on *Aspidiotus camelliae* and *Chionaspis biclavis* in Ceylon. It is probably to be found universally throughout the West Indies, and the genus extends into South America according to Fischer[13], who also records its occurrence in Europe, Australia and New Zealand. So that it would appear to be of nearly world-wide distribution.

Ophionectria coccicola, E. and E. This fungus forms a somewhat cream-coloured stroma from which are produced small, more or less cylindrical, conidial fructifications, which project from the surface of the dead scale insects. When young, these outgrowths are light-brown, but later become coffee-coloured. Finally they are surmounted by a somewhat pyramidal mass of white spores, the whole fructification, including the spores and stalk, measuring about 1 mm. Three spores are borne on each conidiophore; they remain united together by a basal cell, which is the apical cell of the conidiophore. The ascigerous stage of the fungus consists of numerous perithecia borne in groups on the stroma, often associated with the conidial stage. Each perithecium is at first cream-coloured, then light-brown, and finally coffee-coloured and nearly smooth, and opens at the top by a small pore that may be somewhat sunken. The asci are long, rounded at the top, and contain eight hyaline, multicellular ascospores.

The following description of the conidial stage is given by Zimmermann[24] :—

'The conidial fructifications occur partly among the perithecia on a given insect, partly also on neighbouring insects devoid of perithecia. They possess a fuscous stalk, 0·2 mm. long. The head is white, consisting of spores, not surrounded by hairs, collected together into a cone. The conidiophores resemble strings of pearls, and each forms three conidia at the apex, which become free, when ripe, together with the apical cell of the conidiophore. The solitary conidia are drawn out to a point at the free end, many-celled, hyaline 200 - 240 × 6 - 7 Microns.'

At Buitenzorg it was found on *Parlatoria zizyphi*, Luc., which is parasitic on the leaves of *Citrus* sp. Hitherto it has been only reported from America, where it was probably imported from Java.

The description of the perithecial stage, given by Ellis and Everhart[11], is as follows :—

'Perithecia cespitose, membranaceous, about ⅓-mm. diameter and ½-mm. high, flesh-colour, becoming dirty buff when mature, obovate, astomous, surface roughish, with a few scattered white rudimentary hairs, or at length bald. Asci clavate-cylindrical, 150 - 190 × 20 Microns, with abundant rather stout paraphyses. Sporidia eight in an ascus, clavate-cylindrical, multinucleate, hyaline, 110 - 140 × 6 7 Microns at the upper end, attenuated below.

'On dead scale insects on bark of living orange trees, Florida (Scribner).

'The groups of perithecia are seated either on the shells of dead insects or on the bark itself, with a subiculum more or less distinct, composed of white decumbent or prostrate hairs of the same character as those found on the perithecia themselves'

The fungus has been noted as occurring in Java on *Parlatoria zizyphi*. Earle[10] reports its occurrence in Cuba on *Mytilaspis citricola*, as also do Cook and Horne[8]. It has been known for fifteen years in Florida[19] as a most useful parasite of *Mytilaspis citricola* and *M. Gloveri*, though it has not been shown to occur on any other scales in that State.

In that portion of the West Indies dealt with in this article, it is limited to the island of Dominica, and Mr. Jones the Curator of the Botanic Station there, suggests that this is due to its having been accidentally imported into the island on orange trees, obtained from Florida in 1897 for planting.

Orange trees from the same place were imported into Trinidad at the same time, and Mr. Hart thinks it very possible that the fungus may have been introduced on these as well, though further investigation of one or two points is necessary to determine this. Mr. Hart has also informed this Department that he imported specimens of this fungus from Florida, but owing to the pressure of numerous other duties was unable closely to watch its spread at the time. Recently, Massee[16] has described the perithecial stage of a fungus sent him by Mr. Hart from Trinidad, to which he has given the name *Scleroderris gigaspora*; the description closely resembles that of *Ophionectria coccicola*, and it would be interesting to learn if these two are in reality different fungi.

It may be of interest to record here, that the white-headed together with the red-headed and shield scale fungi were found in a clearing in the forest in Dominica on some newly planted lime trees. The seedling plants had probably been obtained from the Botanic Station, which may account for the occurrence of the fungi in such an isolated position, as they were probably conveyed there with the trees. The success of the white-headed fungus in Dominica as a parasite of *Mytilaspis citricola* suggests the advisability of introducing it into the other members of the Windward and Leeward groups. In addition to Java, Florida and Cuba, the fungus is stated by Rolfs and Fawcett[19] to occur in South Africa and South America.

Sphaerostilbe coccophila, Tul. The conidial stage of this fungus, formerly known as *Microcera coccophila*, consists of cylindrical sporodochia about 2 mm. high, arising from a pink stroma; each has a pink and somewhat velvety stalk surmounted by a mass of conidia and conidiophores, of a bright-red and somewhat horny appearance. This stage is followed by the formation of numerous bright-red perithecia, arising from the same stromata as the conidial fructifications. The following is Saccardo's diagnosis[21] of the species:—

'Perithecia very numerous, arising upon or near the conidia-bearing stromata, very small, globular, obtuse, very shortly papillate, very smooth, bright-red, often 4-5 in a group, collapsing when old; asci linear 60 – 80 x 6½ Microns; spores arranged obliquely in a vertical row, ovate, 10 x 5 Microns, uniseptate, subhyaline slightly constricted.—Conidial stage *Microcera coccophila*, Desm. Stromata arising singly from the scales of scale insects, somewhat coarsely terete, obtuse, red, 2 mm high; conidia linear-lanceolate 4-6 loculate, 65 x 6 Microns subhyaline.'

In Florida, Fawcett[12] found that the measurements of the conidia from specimens collected in different localities were 75 - 103 x 5·5 – 8·5 Microns; while the perithecial stage gave measurements as follows:—

Perithecia 350 – 390 Microns long, by 300 Microns thick. Asci 70 – 98 x 8 – 12 Microns. Spores 12 – 18 x 7 – 9 Microns. Both the conidial and ascigerous stages occur in the Lesser Antilles, though the conidial is the more common.

In addition to these two spore forms, Professor Rolfs[20] describes short lateral sterigmata, borne on the vegetative hyphae, from which minute, oval, hyaline conidia are produced; as a variety of this the conidia may be spherical, and produced in short chains on whorled sterigmata, four of which form a whorl. According to the same author, another form of conidia, produced in a similar manner to the last, but having a blue colour, often develops on scale insects kept in a damp chamber. These are sometimes so numerous as to give the insects the appearance of being covered with a blue mould. The delicate forms of spores referred to above serve to increase the numbers of the fungus under favourable conditions. In Dominica, the sporodochia from the interior damp localities are often much larger than the forms found on the coast, and may also be branched, two spore heads being borne on one stalk. Professor Fawcett, to whom specimens of this form were sent, was of the opinion that it was only a variation of the usual form due to exceptionally favourable conditions.

The fungus is of world-wide distribution, occurring in Europe, America, the West Indies, South Africa (Natal and the Transvaal), West Africa, Mauritius, Ceylon, Australia and Japan, and the insects attacked include fifteen species: *Aleyrodes citri*, *Aspidiotus ancylus*, *A. articulatus*, *A. Aurantii*, *A. ficus*, *A. aonidum*, *A. hederae*, *A. obscurus*, *A. perniciosus*, *Chionaspis citri*, *Diaspis pentagona*, *Fiorinia fioriniae*, *Ischnaspis filiformis*, *Mytilaspis citricola*, *M. Gloveri*, *Parlatoria pergandii*. (See Fawcett[12].) In addition to these, probably five new species must now be added for the West Indies, namely: *Asterolecanium pustulans*, *Diaspis* sp. (?), *Dactylopius*) *citri* (?), *Lecanium oleae* and *L. viride* (?). Watt and Mann[22] also record it in India, on *Chionaspis theae*. This gives an idea of the usefulness of this fungus, which is certainly the commonest in these islands, and which like *Myriangium Duriaei* is probably a native species.

SUMMARY.

(1) Four species of fungoid parasites occur on scale insects in the Lesser Antilles, namely: *Cephalosporium lecanii*, *Myriangium Duriaei*, *Ophionectria coccicola*, *Sphaerostilbe coccophila*.

(2) These may be artificially spread either by the spore-spraying method, or the tying-in method.

(3) The fungi are most effective in the islands of Dominica and Montserrat upon the scale insects attacking limes, but are also of general importance in all the islands.

(4) The use of Bengal beans as a cover to trees, more especially lime trees, serves to protect them from attacks of scale insects, probably by encouraging the natural enemies.

(5) The factors which affect the usefulness of these fungi are temperature, wind, and moisture; of these the last two are the most important locally.

(6) The natural means of controlling scale insects is that most suited to circumstances here, both owing to the general conditions and to the much smaller expense involved. Under the exceptional circumstances of an epidemic, the use of non-fungicidal sprays may be found advisable.

In conclusion, the thanks of the Department and of the writer are due to Professor H. S. Fawcett, M.A., of the Florida State Experiment Station, for much valuable assistance and information; to Dr. H. T. Fernald, Ph. D., of the Agricultural Experiment Station, Massachusetts, Mr. J. H. Hart, F.L.S., of Trinidad, and Mr. R. H. Compton, B.A., of Gonville and Caius College, Cambridge, for assistance in obtaining publications, and in other ways.

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See also „ „ Vol. VIII, pp. 186, 202, 299.

SCALE INSECTS AND FUNGOID PARASITES.

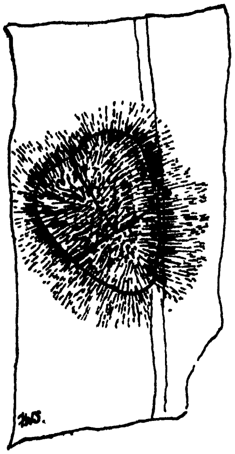


Fig. 1.

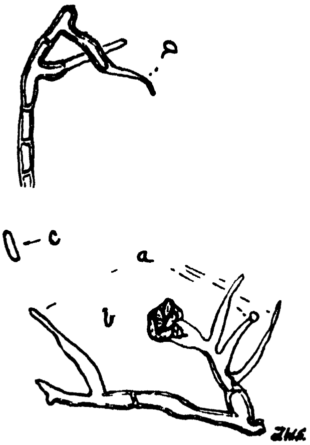
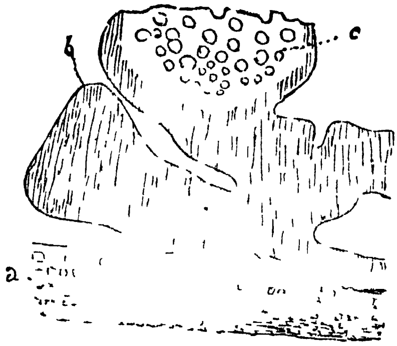


Fig. 2.



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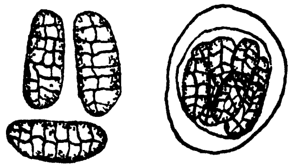

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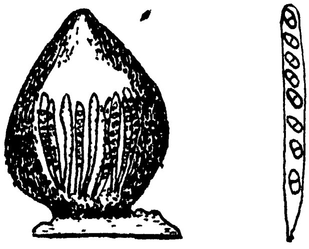


Fig 5.

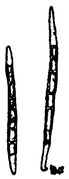


Fig. 6.

Fig. 1. *Cephalosporium lecanii* on *Lecanium mangiferae*. (Slightly magnified.)
Fig. 2. ,, ,, (*a*) conidiophores; (*b*) two united spore heads; (*c*) single spore. (All highly magnified.)
Fig. 3. *Myriangium Duriaei*, longitudinal section of stroma and cleistothecium. After Millardet.
Fig. 4. ,, ,, (left) spores (highly magnified); (right) ascus with eight spores (somewhat less magnified). After Fawcett.
Fig. 5. *Sphaerostilbe coccophila*, (left) longitudinal section of perithecium; (right) ascus with spores. (Highly magnified). After Fawcett.
Fig. 6. *Sphaerostilbe coccophila*, conidia highly magnified.

SCALE INSECTS AND FUNGOID PARASITES.

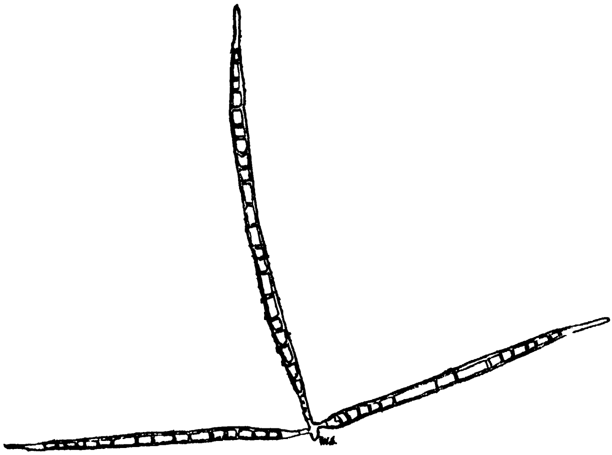


Fig. 2.

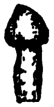


Fig. 1.

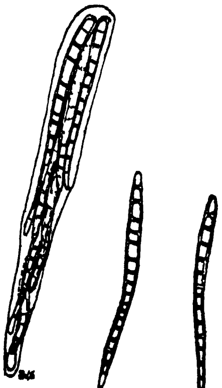


Fig. 4.

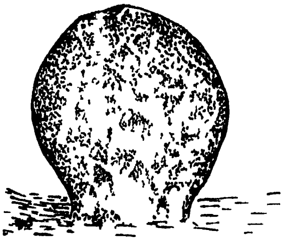


Fig. 3.

Fig. 1. *Ophionectria coccicola*, sporodochium (somewhat magnified). After Fawcett.
Fig. 2. ,, ,, three conidia from one conidiophore. (Highly magnified.)
Fig. 3. ,, ,, perithecium (magnified).
Fig. 4. ,, ,, an ascus and ascospores. (Highly magnified.)

EPIZOOTIC (OR MYCOTIC) LYMPHANGITIS.

The information in the following article is taken from the *Twenty-fifth Annual Report* (1908) of the Bureau of Animal Industry, United States Department of Agriculture. It deals with the disease known as epizootic (or mycotic) lymphangitis, and is especially interesting in view of the presence of this among stock, particularly horses, in the West Indies.

This disease has been known as epizootic lymphangitis, otherwise pseudo-farcy, or Japanese farcy; it is a chronic contagious disease, particularly of equines, caused by a specific organism, *Saccharomyces farciminosus*, and characterized by a suppurative inflammation of the subcutaneous lymph vessels and the neighbouring lymph glands. Owing to the fact that this affection does not spread as an epizootic and that its causal factor is a yeast-like fungus, the name mycotic, instead of epizootic, lymphangitis is suggested. This disease was first described by Italian and French veterinarians, and the specific organism was discovered by Rivolta in 1873. The presence of the disease in the United States was first observed by Pearson in Pennsylvania, in 1907, although it is probable that it has existed in various parts of this country for many years. More recently its presence was definitely established in Ohio, Iowa, California and North Dakota, and there is a probability of its existence in Indiana and several Western States. The disease is also present in the Philippine Islands, Hawaiian Islands and Porto Rico.

BACTERIOLOGY.

Saccharomyces farciminosus forms slightly ovoid bodies, 3 to 5 *Microns* long and 2·1 to 3·6 *Microns* broad, which are somewhat pointed toward the poles and have a sharp double contour. They have more or less of a homogeneous content, and grow by budding. This characteristic can be especially well observed in old growths on culture media. Their staining with the ordinary stains is quite unsatisfactory; they may, however, be readily recognized in fresh smear preparations, or in the hanging drop of a small quantity of the suspected pus, where the above-described bodies can be distinctly noticed.

A satisfactory method of staining the organism is the Claudius method, which is as follows:—

(1) Stain with 1 per cent. aqueous solution of methyl violet for two minutes.

(2) Place in a half-saturated solution of picric acid for one to two minutes.

(3) Decolourize with chloroform or clove oil.

(4) Treat with xylol.

(5) Mount in Canada balsam.

The organisms grow very slowly in the various culture media. It requires about ten days before vegetation is noticed on agar, in the form of grayish-white granules, which gradually grow to larger colonies, appearing considerably elevated, and having a wrinkled surface. They also grow in bouillon, in which a white flaky deposit makes its appearance after fifteen or eighteen days. In taking cultures, it is advisable to open a fluctuating abscess, over which the skin should be shaved and well cleaned with bichloride solution and alcohol. The abscess should be opened with a sterilized scalpel, and culture media may then be inoculated in the usual way. In case of a mixed infection, the organism may be isolated by plating.

The period of incubation varies greatly, extending from three weeks to four months, or even longer. In artificial inoculations with pus through wounds in the skin, inflammation and swelling of the lymph vessels may be noticed in twenty to sixty days, and these show in their course a development of hard nodules, from which abscesses form.

The natural infection is without doubt caused through superficial wounds, such as galls, barbed wire cuts, or through various stable utensils, harness, bandages, insects, etc. Solipeds are mostly susceptible, but cattle may also be infected.

SYMPTOMS.

The inflammation of the lymph vessels is usually first observed on the extremities, especially on one or both hind legs; it may also appear on the fore legs, shoulder, or neck, and more rarely on the rump, udder and scrotum. The lesions, as a rule, develop in the tissue adjacent to the place of inoculation. In the early stages of the disease, the lymph vessels appear very hard and thickened, and along their course hard nodules develop, ranging in size from a pea to a hen's egg. Later, these nodules soften, burst spontaneously, and discharge a thick yellowish pus. The surface of the resulting ulcers or abscess cavities soon fills up with exuberant granulations, which protrude beyond the surface of the skin, giving a fungoid appearance. The affected extremities are considerably enlarged, similar to cases of simple lymphangitis. In rare cases the mucous membrane of the nostrils may also become affected, showing yellowish flat elevations and ulcerations, and these may extend by metastatis to internal organs. In cases where the mucous membrane is affected, the submaxillary lymph gland may also become enlarged, and suppurate.

The constitutional symptoms accompanying this disease are not very marked, or may be altogether absent. There is usually only very slight fever, which seldom runs over 102° F. The appetite is not impaired except in the advanced cases.

LESIONS.

The anatomical changes are most marked in the skin and the subcutaneous tissues. They may become 2 to 3 inches thick, and indurated as the result of fibrous-tissue formation, due to the inflammation present. On the bacon-like cut surface, suppurative areas and granulating sores may be noticed of various sizes, also enlarged lymph vessels filled with clotted lymph mixed with pus. The neighbouring lymph glands are usually enlarged, and frequently contain suppurating foci. Rarely, the internal organs may show metastatic abscesses.

DIAGNOSIS.

The diagnosis is based on the characteristic appearance of the ulcerations, which show exuberant granulation of a bright-red colour, inverted edges, and a thick, creamy, glutinous discharge. These manifestations differentiate the disease from glanders, in which the ulcers are craterlike, do not contain exuberant granulations, and the discharge is of a viscous, oily character. The submaxillary and other lymph nodes, as well as the corded lymphatics, in glanders, are more firmly attached to the adjacent tissues, and are therefore less movable. In some chronic cases of mycotic lymphangitis, however, the lesions may closely resemble those of farcy, and in these the microscopical examination of the pus will disclose the nature of the affection. In the pus, the Saccharomyces can be easily seen in the unstained specimen, and is recognized by its size, shape and highly refractory double outline. Furthermore, the injection of mallein in cases of mycotic lymphangitis will be attended with negative results.

TREATMENT.

Treatment consists, at the onset of the disease, in entire extirpation of the nodules, lymph vessels and neighbouring lymph glands, in case the lesions are localized. In cases where the nodules have formed abscesses, their opening is recommended, followed by the application of the actual cautery or a 1-in-250 solution of bichloride of mercury. It must be borne in mind that the organism is highly resistant to almost every antiseptic, and the best results will be obtained from the application of a solution of a strong antiseptic, following the opening of the lesions.

In the most favourable cases, recovery results in from five to seven weeks: as a rule, however, it requires several months.

PROPHYLAXIS.

In order to prevent the spreading of the disease, the affected animals should be isolated, the products of the disease destroyed, and the stable desinfected with very strong liquid disinfectants, in consideration of the great resistance of the causative organism.

A NEW WEST INDIAN CACAO POD DISEASE.

BY C. K. BANCROFT, B.A., (Cantab.).

Five species of *Colletotrichum* have been previously recorded on the cacao plant. They are distributed over the West Indies, Cameroons and Surinam and have been named *C. luxificum*, van Hall and Drost; *C. Theobromae*, Appel and Strunk; *C. theobromicolum*, Delacroix; *C. brachytrichum*, Delacroix, and *C. incarnatum*, Zimmermann.

Recently, a fungus belonging to the genus *Colletotrichum* has been observed on two separate samples of diseased cacao pods received at the Royal Botanic Gardens, Kew, from Jamaica. The fungus was present on all the pods, while on some of them *Phytophthora omnivora*, de Bary, and *Diplodia cacaoicola*, P. Henn., were also observed, these two latter being the fungi which are responsible, respectively, for the 'black pod' and 'brown pod' diseases of the cacao plant.

The conidia-bearing pustules of the species of *Colletotrichum* occurred on the surface of the pod in the form of sub-tremelloid masses, which were yellow at first and later assumed a pink colour. Formed just under the epidermis, these acervuli appeared to become early erumpent. The conidia were borne singly at the tips of conidiophores, each conidiophore being at least greater in length than the conidium which it bore. The conidia were hyaline, pinkish in mass, continuous, oblong, rounded at both ends, slightly constricted at the middle, and measured 14-17 x 5 *Microns*; the conidiophores were hyaline, and measured 20-24 *Microns* in length; the setae were straight, rigid, tapering to a point, 2-3 times septate, 70-100 *Microns* long by 4-5 broad, and had a distinct purplish tinge.

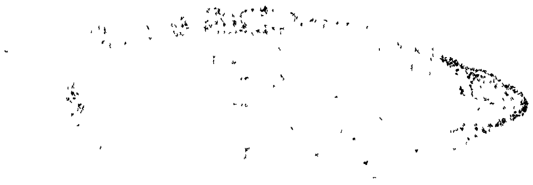
The characters of the setae were constant for all the specimens examined, and were regarded as being definite and distinct from those of any other known species of *Colletotrichum*. It has, therefore, been thought fit that this should be designated a new species, and it has been named *Colletotrichum Cradwickii*, after its discoverer, Mr. Cradwick, travelling instructor of the Agricultural Department at Jamaica.

The pods on which the fungus occurred were small and very hard, and along with the acervuli there occurred hyphae which could be traced as far inward, in the pod, as the mucilaginous covering of the seeds. The hyphae were for the most part intracellular, were septate, were variously branched, and measured, on the average, 4 *Microns* in width.

The absence of material available for infection prevented any investigation of the parasitism of the fungus. Cultural experiments were, however, conducted, and these failed to show that the fungus was capable of giving rise to any other spore form.

It remains, therefore, to investigate the parasitism of *Colletotrichum Cradwickii.*

A NEW WEST INDIAN CACAO POD DISEASE.



Pod showing Pustules of the Fungus on its Surface

Pustule in section, showing Conidiophores, Conidia and Setae.

Three Conidia,
more highly
magnified than
above.

The following are useful references to the species of Colletotrichum occurring on cacao :—

Hall and Drost, *Recueil des Trav. Bot. Néerl.*, Soc. Bot. Néerl., IV, p. 243, 1908.

Delacroix, 'Champignons parasites de plantes cultivées dans les regions chaudes'. *Bull. de la Soc. Myc. de France*, Vol. XXI, p. 191, 1905.

F. C. Von Faber, *Die Krankheiten und Parasiten des Kakaobaumes*, 1909.

NOMENCLATURE OF SCALE INSECTS.

BY H. A. BALLOU, M.Sc.,

Entomologist on the staff of the Imperial Department of Agriculture for the West Indies.

The scale insects of the West Indies have been dealt with in two papers published by the Imperial Department of Agriculture. One of these appears under the heading 'Scale Insects of the Lesser Antilles', which was published in two parts in the Pamphlet Series of the Department's publications, Part I being Pamphlet No. 7, and Part II Pamphlet No. 22. These were issued in 1901 and 1903, respectively.

This account includes the important pests and well-known forms of this group of insects together with remedies, food plants and distribution. The other paper, which is entitled 'Scale Insects in the West Indies', appeared in two numbers of the *West Indian Bulletin*, and is to be found on pp. 240-70, and 295-319 of Vol. III of that publication.

This account of the scale insects is more technical than the former, and includes in the first part several species which are not mentioned in the pamphlets; while the second part contains a scientific account where subjects such as the following are dealt with: native and introduced species: species likely to be introduced into foreign countries from the West Indies; wild and cultivated species. Other subjects are also included.

Early in 1903, Mrs. Fernald's *Catalogue of the Coccidae of the World* was issued. This is the most complete work of the kind that has ever been published. It has created some confusion from the fact that very extensive changes in names have been made. As these changes have been very largely accepted by entomologists in all parts of the world, it happens that insects which are well known under the names they formerly bore, are now always referred to by names so dissimilar that workers generally, except entomologists, are unlikely to be able to recognize the reference. The object of the present short paper is to place before the readers of the *West Indian Bulletin* a list of the names, which will enable them to avoid the difficulty arising from these changes in the case of the better-known forms in the West Indies.

In the following list it will be seen that the names are presented in three columns: the first contains the old scientific name; the second the new scientific name, and the third the common name.

The old names are those with which the readers of the publications of this Department are likely to be most familiar, since they are the ones used in the articles on scale insects to which reference is made. They are arranged alphabetically by genera, and opposite to each one is given the name under which that insect is catalogued in Mrs. Fernald's book, while the common name in the third column is that which is used in the pamphlets already mentioned, and in the Department's publications generally. Where blanks occur in the second column, it will be understood that no change in the name has been made, the old scientific name being that given in Mrs. Fernald's catalogue:—

Old Name.	New Name.	Common Name.
Aspidiotus		
articulatus	*Selenaspidus articulatus* (Morg.)	West Indian Red scale
aurantii	*Chrysomphalus aurantii* (Mask.)	Orange Aspidiotus.
biformis	*Chrysomphalus biformis* (Ckll.)	Orchid Aspidiotus.
camelliae	*Aspidiotus rapax* (Comst.)	Greedy scale
cydoniae (Comst.)	... ...	Grape vine Aspidiotus.
destructor (Sign.)	... ...	Bourbon Aspidiotus.
dictyospermi	*Chrysomphalus dictyospermi* Morg.	Dictyospermum Aspidiotus.
ficus Ashm.	*Chrysomphalus aonidum* Linn.	Red Spotted scale.
hartii (Ckll.)	.. ...	Yam scale.
hederae Vall.	... ...	Oleander scale.
personatus	*Chrysomphalus personatus* Comst.	Masked Aspidiotus.
punicae	*Aspidiotus cydoniae punicae* (Ckll.)	
sacchari Ckll.		Sugar-cane Aspidiotus.
tesseratus	*Pseudaonidia tesserata* (de Charm.)	
Asterolecanium		
bambusae Boisd.	... ...	Bamboo Fringed scale.
bambusulae Ckll.	... ...	
pustulans Ckll.	... ...	Akee Fringed scale.
urichi Ckll.	... ..	
Aulacaspis		
pentagona (Targ.)	... ...	West Indian Peach scale.
rosae (Bouché)	... ...	Rose scale.

Old Name	New Name.	Common Name.
Ceroplastes		
cirripediformis Comst.	... ...	Barnacle wax scale.
cirripediformis var. *Plumbaginis*	*Ceroplastes plumbaginis* Ckll.	
denudatus (Ckll.)	...	
dugesii	...	Pink wax scale.
floridensis Comst.	...	Florida wax scale.
Ceroputo		
barberi (Ckll.)		
Chionaspis		
biclavis	*Howardia biclavis* (Comst.)	Burrowing scale.
citri Comst.	...	Orange snow scale.
major Ckll.	...	
minor	*Hemichionaspis minor* (Mask.)	Small snow scale.
Dactylopius		
adonidum	*Pseudococcus longispinus* (Targ.)	Long-tailed mealy bug.
barberi	*Ceroputo barberi* (Ckll.)	Barber's mealy bug.
brevipes	*Pseudococcus brevipes* (Ckll.)	Pine-apple mealy bug.
calceolariae	*Pseudococcus calceolariae* (Mask.)	Pink sugar-cane mealy bug
citri (Boisd.)	*Pseudococcus citri* (Risso.)	Common mealy bug.
dubia (Newst.)	*Pseudococcus pseudonipae* (Ckll.)	Cocoa-nut mealy bug.
nipae	*Pseudococcus nipae* (Mask.)	
sacchari	*Pseudococcus sacchari* (Ckll.)	Grey sugar-cane mealy bug.
virgatus	*Pseudococcus virgatus* (Ckll.)	Spotted mealy bug.
Diaspis		
amygdali	*Aulacaspis pentagona* (Targ.)	
boisduvalii Sign.		Cocoa-nut snow scale.
Boisduvallii, var. *maculata* (Ckll.)		Pine scale.
calyptroides,	*Diaspis echinocacti* (Bouché)	Cactus scale.
calyptroides var. *opuntiae*	*Diaspis ehinocacti opuntiae* (Ckll.)	
rosae	*Aulacaspis rosae* (Bouché)	Mango snow scale.
Fiorinia		
fioriniae (Targ-Tozz.)	*Fiorinia fioriniae* (Targ.)	
Icerya		
montserratensis Riley and Howard	...	
rosae	*Palaeococcus rosae* (Riley & Howard)	Rose icerya.
Ischnaspis		
filiformis Sign.	*Ischnaspis longirostris* (Sign.)	Black line scale.
Lecanium		
batatae Ckll.	*Mesolecanium batatae* (Ckll.)	
begoniae Dougl.	*Saissetia begoniae* (Dougl.)	
depressum Sign.	*Saissetia depressa* (Targ.)	
hemisphaericum	*Saissetia hemisphaerica* (Targ.)	Brown shield scale.
hesperidum	*Coccus hesperidum* (Linn.)	Common shield scale.
longulum	*Coccus longulus* (Dougl.)	Long shield scale.

Old Name.	New Name.	Common Name.
mangiferae	*Coccus mangiferae* (Green)	Mango shield scale.
nigrum	*Saissetia nigra* (Nietn.)	Hibiscus shield scale.
oleae	*Saissetia oleae* (Bern.)	Black shield scale.
punctatum (Ckll.)	*Akermes punctatus* (Ckll.)	
tesselatum (Sign.)	*Eucalymnatus tesselatus* (Sign.)	Tesselated shield scale.
Urichi Ckll.	*Neolecanium urichi* (Ckll.)	
Margarodes		
formicarium (Guild.)	...	Ground pearl.
Mytilaspis		
citricola (Pack.)	*Lepidosaphes beckii* (Newm.)	Orange mussel scale.
gloveri	*Lepidosaphes gloverii* (Pack.)	Glover's scale Long mussel scale
buxi	*Pinnaspis buxi* (Bouché.)	Small mussel scale.
Orthezia		
insignis Dougl.	...	Lantana bug.
praelonga Dougl.	...	Croton bug.
Parlatoria		
proteus, var. *crotonis* Dougl.	*Parlatoria crotonis* (Dougl.)	
Pinnaspis		
buxi (Bouché)		
Protopulvinaria		
pyriformis	*Pulvinaria pyriformis* Ckll.	Mealy shield scale.
Pseudococcus		
tomentosus newsteadi Ckll.	*Dactylopius tomentosus* (Lam.)	
Pulvinaria		
ficus Hemp.	...	Guava mealy scale.
simulans Ckll.	...	Ribbed mealy scale.
urbicola Ckll.	...	Capsicum mealy scale.
Vinsonia		
stellifera Westw.	...	Glassy star scale.

NOTES ON LIME CULTIVATION.

BY H. A. BALLOU, M.Sc.,

Entomologist on the Staff of the Imperial Department of Agriculture for the West Indies.

The cultivation of limes has been an industry of great importance in the West Indies for many yesrs, especially in Dominica and Montserrat. In Dominica, a considerable number of estates make limes the principal crop, while in Montserrat the cultivation of this product has been largely in the hands of one company. Limes, like other citrus crops, are always liable to attacks of pests and diseases, and in this respect, the experience in the West Indies has been no exception to the general rule. The principal injurious insects encountered in these islands have been scale insects, which from time to time have caused considerable losses by their attacks on the trees. In these notes a brief account is given of the cultivation experiments which have been in progress in Montserrat for the past three years. To this are added general observations on the conditions of the limes in that island and in Dominica, with regard to the attacks of scale insects and their control.

The experiments were inaugurated during 1907, with a view to acquiring more definite information as to the effect of different methods of cultivation, and also as to the relative value of different insecticides for the control of pests in one field. For this purpose two series of experiments were laid out. That which was intended for trials in spraying consisted of five plots, but as no serious outbreak of scale insects has occurred on these, no application of sprays has been made to them. The experiments in the methods of cultivation, on the other hand, have been in operation from then up to the present time. The intention of the experiments is that the same lines of treatment shall be continued for a considerable period longer, in order that conclusive results may be obtained, and that the preliminary conclusions already arrived at may be either confirmed or modified.

The field in which the experiments were carried out belongs to the Montserrat Company, and it was through the courtesy of the Hon. F. Driver, the attorney and manager, that it was made available for experimental purposes to officers of the Imperial Department of Agriculture.

The experiments consist of five plots, each of which is ¼-acre in area, and contains thirty-six trees in three rows. The plots are situated at a corner of a large field. The aspect of the land is westerly, that is to say, it is on the western slope. The plots are numbered from south to north. On the southern side is an estate road bordered by a white cedar wind-break, which separates plot 1 from the road; the eastern, or uphill, side is bordered by a white cedar wind-break, which divides the plots from the main portion of the field, and on the western side there is another estate road. An additional small wind-break runs east to west through plot 4. The rows of each plot run from east to west. The trees were planted in 1904. At the time the experiments were laid out in 1907, the trees on plots 1, 2 and 3 were slightly larger than those on plots 4 and 5, but the difference in size was not great.

The methods of cultivation which are being tested in these five plots are as follows:—

Plot 1 is cutlassed from time to time; the grass and weeds are allowed to grow right up to the base of the tree; and no forking or hoeing is done in this plot.

Plot 2 is farmed, i.e., it is kept in clean condition by hoeing, which operation is performed once a fortnight.

Plot 3 is forked twice a year and the weeds and grass are cutlassed down at intervals.

Plot 4 is forked twice a year and receives also the ordinary treatment of the adjoining lime cultivations.

Plot 5, which is called the control plot, receives only the cultivation of the adjoining fields. This consists of two or three hoeings each year. The operation of hoeing in Montserrat is intermediate between cutlassing and forking; that is, it disturbs the surface of the soil and the grass roots more than cutlassing, but it does not penetrate as deeply as forking.

These experiments were inaugurated under the general direction of the Superintendent of Agriculture of the Leeward Islands, and have been under the immediate supervision of Mr. W. Robson, the Curator of the Botanic Station. They are mentioned in the *Reports on the Botanic Station and Experiment Plots, Montserrat*, 1907-8, and in the similar report for the following year an account is given of the experiments and the condition of the trees up to June 30, 1909.*

A few trees of these plots bore limes in 1908, that is when they were four years old, but the measuring, for record, of the first picking, did not begin until January 1, 1909. The first six months of picking from these trees is given as follows:—

Plot 1, 4 barrels; plot 2, 51 barrels; plot 3, 4 barrels; plot 4, 8 barrels; plot 5, 4 barrels. It will be seen from these figures that the yield from plot 2 was very greatly in excess of that from any other plot. At this time (June 30, 1909), the trees on plot 2 were much larger than those on any of the other plots; they were of uniform size and presented an appearance of most excellent growing condition. The trees on plots 1 and 3, although smaller than those on plot 2, were very regular and uniform in size, and there was very little difference in the trees of these two plots. The trees on plots 4 and 5 were slightly smaller than those on plots 1 and 3.

The Curator, who had charge of these experiments, anticipating that the heavy bearing by the trees on plot 2 would have an exhausting effect, gave a normal dressing of pen manure at the end of February 1909, to the windward half of the plot, and from that time on, the limes were collected and gathered separately from the two halves of plot 2. During the four months following (March to June) the unmanured half of this plot yielded one and a half times as many limes as the manured half. The effect of the manure was to be seen in an increase in the size, and appearance of vigour, in the trees. The so-called 'normal' dressing of pen manure is a variable quantity, and although this is the ordinary expression, I was unable to get figures by which to express the amount applied per tree or per acre.

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* Reports on the Botanic Station and Experiment Plots, Montserrat.
1907-8, p. 13.
1908-9, p. 11.

At the end of June, plots 1, 3, 4 and 5 were comparatively free from insect pests, while No. 2 was severely attacked by the green shield scale (*Lecanium viride*). The contrast in appearance between No. 2 and the other plots was very marked, the difference in size having very materially increased between the trees of this one and those of 1 and 3.

At the end of the year (December 1909) these plots were visited by the Imperial Commissioner of Agriculture, who found that the attack of the green shield scale on the manured trees of plot 2 (both halves) had been followed by a very severe attack of the purple scale (*Mytilaspis citricola*), and that many trees appeared to be in a dying condition, or at least to have a very large amount of dead or dying wood in their tops. The unmanured portion of the plot also showed the effect of the attacks of the green and purple scales, but not in so marked a degree as the manured portion. Plots 1 and 3 were slightly attacked by green and purple scale, but this was only to be seen in the case of those trees which bordered on plot 2, or came in contact with infested trees in that plot.

In March 1910, the Mycologist on the staff of the Department, and the writer, visited Montserrat for the purpose of inspecting the lime experiment plots, and of making observations on the conditions of the lime cultivations in the island generally. The plots had undergone some change in appearance since the visit of the Imperial Commissioner in the previous December. Plot 2 still showed the effect of a severe attack of the purple scale, the green scale having very largely disappeared. The cause of the disappearance of the green scale when followed by the purple scale has not been determined. All the trees in this plot seemed to have suffered a check in growth, and those on plots 1 and 3 had nearly equalled them in size, so that the difference was much less than when they were previously reported on. Plots 1 and 3 showed the attack of the purple scale to a slight extent. Those trees which were seen to be attacked in December had a certain amount of dead wood among the branches, but the attacks of purple scale had not spread. The green and purple scales were not present on plots 4 and 5 in any numbers. The white scale (*Chionaspis citri*) was to be found in small quantities on all the plots. The purple scales that were seen in March were accompanied by several natural enemies, especially lady-birds, lace-wing fly and *Syrphus* fly. The red-headed fungus (*Sphaerostilbe coccophila*) had been present at one time but had disappeared. The white scale was in every instance accompanied by the parasitic black fungus (*Myriangium Duriaei*).

The trees of plot 2, in addition to suffering from attacks of scale insects, were found to be attacked by a root disease, and it seems likely that the continual clearing of the surface soil may have produced an injury to the smaller roots and allowed the entrance of disease-producing organisms.

Plot 1 is of considerable interest, since on this the surface of the ground experiences the least disturbance of all the plots ; the grass and weeds are allowed to make continuous growth, as far as the roots and soil cover are concerned, the weeds themselves being cutlassed down as they get too high. This cutlassing in plot 1 had not been done for some little time previous to our visit, and a considerable collection of insects was made by sweeping with the net. This collection was found to contain a large number of parasitic Hymenoptera. Although the species have not been determined and the habits are not definitely known, it is almost certain that these are beneficial insects, and the fact that the soil cover of weeds and grass affords protection and hiding place for insects of this kind, may have an important bearing on the relation which exists between such cultivation and the comparative freedom of the trees from injurious insects.

In plot 2, the conditions were of course such that no hiding-place was offered for insects, except on the trees themselves, and in plots, 3, 4 and 5 the routine operations of cultivation had been carried out just previous to the visit, so that it was impossible to make any collections in these plots which would in the least be comparable with that made in plot 1. A small one was, however, made by sweeping in the grass of a newly planted lime field, to the south of plot 1, across the estate road mentioned already. This field was little more than an open pasture, for the young limes had only been planted recently, and the grass and weeds had evidently not been disturbed since the preparation of the land, except just around each tree, where a small area was kept clean. Sweeping in this field revealed the presence of fewer insects in hiding, than in plot 1, though the insects themselves were of related kinds, a few species of parasitic hymenoptera being represented.

The yields of fruit obtained from the plots during the year ended June 30, 1910, were similar to those of the first period of six months. The proportionate increase was less on plot 2 than on any of the others. For convenience of reference the yields are given in the accompanying table for the two periods recorded :—

Plot.	Half-year ended June 30, 1909.	Year ended June 30, 1910.	Total.
1	4 barrels	10 barrels	14 barrels
2	51 "	55 "	106 "
3	4 "	10 "	14 "
4	8 "	11 "	19 "
5	5 "	12 "	17 "

In the first return of 51 barrels from plot 2, about 30 were from the unmanured half, and about 20 from the manured half. In the second return of 55 barrels, this yield was almost equally divided between the two halves of the plot. Another aspect of the whole question is to be found in the relation between the rate of growth and bearing and the longevity and healthfulness of the trees. The conditions on plot 2 have produced almost a maximum bearing (200 barrels per acre) in four years from planting, and this is repeated in the following year. In other words, here are thirty-six trees five years old, which have produced 106 barrels of limes in one and a half years of bearing, whereas the best of the other plots have produced 19 barrels only. Further returns from these plots should indicate whether this increased early yield is profitable in the long run. The cost of the extra labour is only one item. The abundance of scale insects, the possible increase of root disease on lands so cultivated, and the total life of the tree must all be taken into consideration.

The conclusions to be reached from these experiments must be regarded as merely preliminary, but it may not be out of place to indicate what they seem to show at present. As far as the growth and general vigour of the trees are concerned, there seems to be but little difference between the plots, with the exception of plot 2. This, which at one time made more rapid growth than the others, and presented an appearance of remarkable vigour, has suffered a check, the trees on the other plots meanwhile making steady growth. Plots 1 and 3, on the whole, presented a most healthy and vigorous appearance, the only exception to this being the few trees infested by purple scales, which apparently had been communicated from infested trees in plot 2. Plots 4 and 5 were comparatively free from scale insects, and the trees were strong and healthy in appearance, though slightly smaller than those of the other plots. It is not possible to say whether the difference in size was more marked at this time than when the experiments were laid out.

The most striking conclusion which is presented for consideration by these experiments is that clean cultivation may produce very vigorous growth for a short time, but any improvement resulting from this treatment is not likely to be permanent, and trees so cultivated are liable to attack by scale insects, especially the green and purple scales.

In this connexion it may be well to note that the portion of the field of limes which was to windward of the plots, and separated from them by the cedar wind-break, and which had been covered with Bengal beans during the season 1909-10, was fairly free from scales at the time of our visit. If infestation was communicated to plot 2 from this field, the attack on the plot must have begun previous to the time in 1909 when the beans formed a cover over the trees. Another point is that there was apparently no opening in the cedar hedge that would make the infestation of plot 2 more likely than that of the other plots.

A small plot of spineless limes at the Botanic Station, which has received cultural treatment similar to that given to plot 2, may be mentioned as a parallel instance of the severe attack of purple scale following clean cultivation.

These trees experienced a severe attack of purple scale, which had extended over a considerable period of time, and they had been sprayed repeatedly with several different spray mixtures. In spite of this, however, the attacks of purple scale persisted.

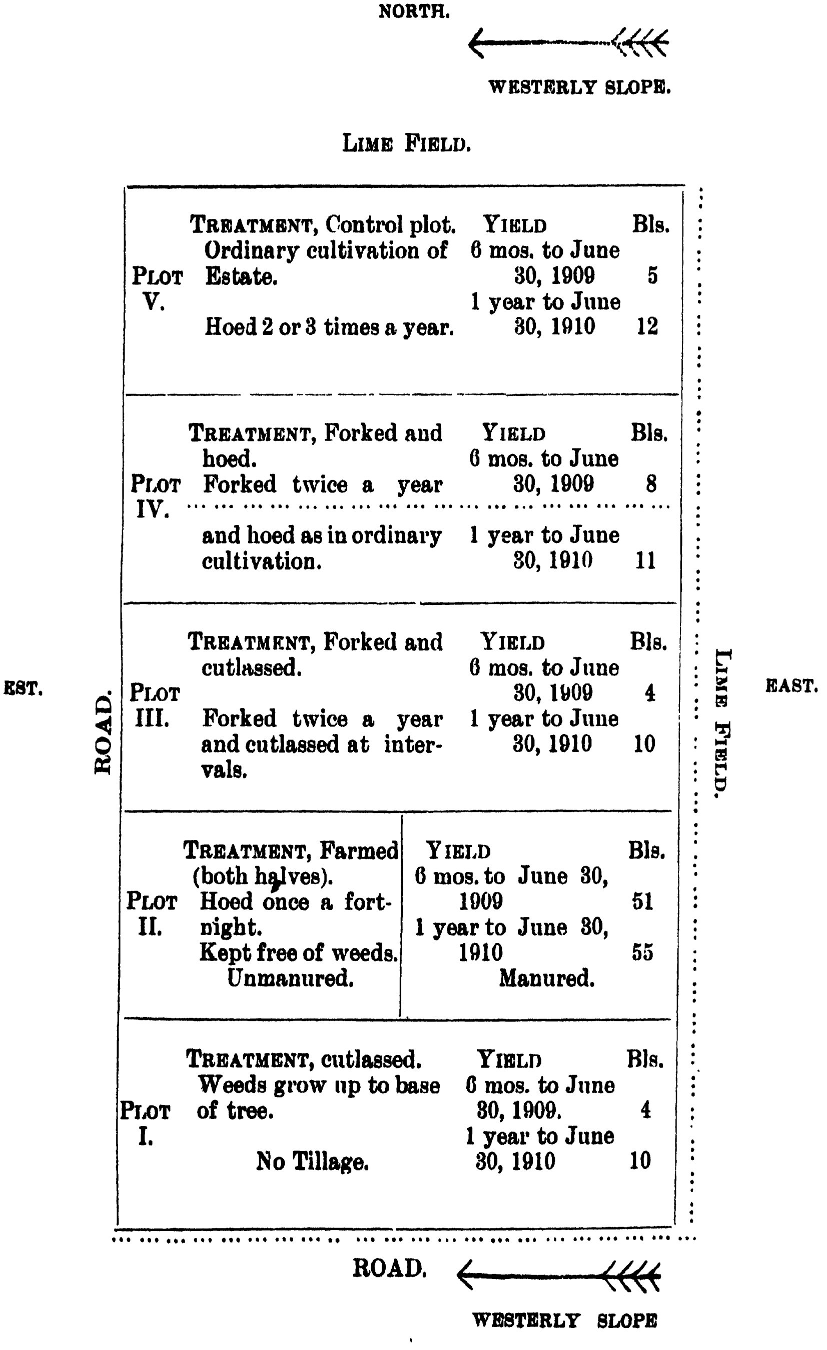
Mr. Driver expressed his belief that abandoned trees growing in bush were less liable to attack by scales than those growing in the fields under cultivation, and in support of this theory he showed us trees at Richmond which had been injured in the hurricane of 1899 and then abandoned. These were small trees without dense foliage, but they showed the presence of very few scale insects, and their condition was better than that of any of the other trees which we saw, that had been damaged by the hurricane.

The red-headed and the black fungi were present, and there were evidences of the attacks of hymenopterous parasites on the purple scales. A few lady-birds were also seen on these trees.

It should be borne in mind that the foregoing observations and results relate to the experiments, which cover only a small area, and not to the general cultivation of limes in Montserrat, which is very extensive. The experiments have been conducted for the purpose of demonstrating the sequence of events, where exact observations can be made and where conditions are under control, and it is hoped that information derived from the continuation of this experimental work may be finally available for the benefit of the general cultivation.

PLAN OF EXPERIMENT WITH LIME TREES.

(Dotted lines show position of White Cedar wind-breaks.)



	Treatment	Yield	Bls.
PLOT V.	TREATMENT, Control plot. Ordinary cultivation of Estate. Hoed 2 or 3 times a year.	6 mos. to June 30, 1909	5
		1 year to June 30, 1910	12
PLOT IV.	TREATMENT, Forked and hoed. Forked twice a year	6 mos. to June 30, 1909	8
	and hoed as in ordinary cultivation.	1 year to June 30, 1910	11
PLOT III.	TREATMENT, Forked and cutlassed. Forked twice a year and cutlassed at intervals.	6 mos. to June 30, 1909	4
		1 year to June 30, 1910	10
PLOT II.	TREATMENT, Farmed (both halves). Hoed once a fortnight. Kept free of weeds. Unmanured.	6 mos. to June 30, 1909	51
		1 year to June 30, 1910 Manured.	55
PLOT I.	TREATMENT, cutlassed. Weeds grow up to base of tree. No Tillage.	6 mos. to June 30, 1909.	4
		1 year to June 30, 1910	10

GENERAL NOTES.

In 1894, Professor C. V. Riley, at that time Entomologist of the United States Department of Agriculture, visited Montserrat, at the invitation of the Montserrat Company, accompanied by Mr. H. G. Hubbard, for the purpose of making trials in the control of scale insects by means of spraying and fumigating. Mr. Hubbard spent some weeks in the island and made repeated experiments. He concluded that fumigating was not likely to be successful, because of the strong winds which blow across the island at most parts of the year, and which have a tendency to exhaust the gas under the tents before it has an opportunity to act on the insects, and, moreover, the broken and hilly nature of many parts of the island render this process a very expensive one. In addition to this, the value of the individual trees is small compared with the cost of fumigating. Spraying, however, was recommended, and this measure has been carried out from time to time. Different kinds of sprayers and a variety of insecticides have been used, but these have not been altogether successful in preventing the attacks of scale insects. It was also suggested that dependence should be placed on the action of the natural enemies of the scales, and that artificial manures should be used to promote vigorous growth of the trees.

The scale insects concerned in the injury to the lime trees in Montserrat at present are the purple scale (*Mytilaspis citricola*), the white scale (*Chionaspis citri*) and the green scale (*Lecanium viride*) ; but at the time of the visit of Riley and Hubbard, only two of these insects were recorded as pests, i.e., the white and the purple scales ; and these were thought to be the only scale insect pests of limes that need be taken into consideration. The white scale was looked upon as being of greater importance than the purple scale.

In April 1903, on the occasion of my first visit to Montserrat, the same condition was observed. No green scale was noticed, and the white seemed to be of more importance than the purple scale. In 1909 and 1910, however, the position is changed. The white scale is now of least, and the purple of most, importance, and the green scale which had been present in sufficient numbers to be considered a pest only for some five years, ranks next to the purple scale in the severity of its attacks.

Lefroy, in his paper on the Scale Insects of the Lesser Antilles (Pamphlet Series, No. 7, 1901), mentions *Lecanium hesperidum* as occurring on lime and other citrus plants, and records this species from Montserrat, but does not mention *L. viride.* This is probably due to mistaken identity, and it is likely that the previous records of *L. hesperidum* included the records of *L. viride*, which latter species was identified by Mr. E. E. Green, Government Entomologist, Ceylon, from material forwarded from several localities in Dominica in 1905. *Lecanium viride* would then seem to be a pest of limes of comparatively recent standing, in the West Indies, at least.

In every recorded instance of *L. viride* attacking limes seriously in these islands during the past five years, the attack has been of short duration, and the insect has decreased in numbers without the use of artificial measures. The exact cause of this decrease is not known in all cases. The shield scale fungus in certain instances may have been instrumental in bringing it about, in Dominica, but as this parasite has not been found attacking the green scale on limes in Montserrat, the results must be ascribed to some other cause in that island.

It has been mentioned already, in discussing the conditions of plot 2, that the green scale attacks the plants first, and this is followed by an attack of the purple scale. It is not possible to say how much damage is done by the green scale, but the obvious injury seems to be due to the subsequent attack of the purple scale. The injury to young, tender growth, due to the green scale, is probably a serious check to the tree which, however, may assist the purple scale to make the rapid development already noted.

The first trials of spraying in Montserrat were in the use of kerosene emulsion, and recently, other insecticides have been tried, whale oil soap, whale oil soap and kerosene emulsion, rosin wash and rosin compound, and lime, salt and sulphur, being among the number. Spraying has been useful in bringing scale insects under control, in the case of serious outbreaks.

In Dominica, a serious outbreak of scale insects occurred in 1902-3, when the purple scale was much the most serious pest, and the white scale only troublesome to a slight extent. The green scale was not observed as a pest on limes at that time. Since 1905, however, the last-mentioned insect has appeared in several places and threatened to become a pest, but has subsided almost in every instance without treatment.

During the outbreak in Dominica in 1902-3, spraying operations were carried out on several estates, and on certain of these a limited amount of spraying was done in the following season. Many estates did no spraying even when the trees were in a seemingly hopeless condition, but it is to be recorded, that on the majority of these estates, most of the trees recovered. A few died, and in many a greater or smaller portion of the top died out.

In certain districts of the island, however, there seems to be no doubt that spraying was most beneficial, and on certain estates where energetic measures were adopted, not only were many trees saved that would otherwise have died, but the normal yield was restored in a much shorter time than would otherwise have been the case.

Since 1903-4, practically no spraying has been done in Dominica, and there has been no serious outbreak of scale insects in that island during the period. The natural enemies of the scale insects have maintained a fairly satisfactory control, without much assistance; this may be due to the more favourable climatic conditions of more rainfall and higher percentage of humidity, which exist in Dominica.

Natural enemies of scale insects have been known to occur in Montserrat, but when left to themselves they have not maintained such a regular control as in Dominica. By the use of Bengal beans, however, a natural control, that is a control without the use of insecticides, is brought about.

The story of the use of Bengal beans in Montserrat in connexion with the scale insects on limes has been told in the *Agricultural News* (see Vol. VIII, p. 154) and also in this volume of the *West Indian Bulletin** (see p. 1). Badly infested trees are covered by a growth of beans which are planted in May or June and cutlassed the following February or March, the mass of vines on the top of the trees being left undisturbed.

The results of this treatment are the almost complete disappearance of the scales and a greatly increased vigour of the trees. It is not possible to state exactly at present in what way the favourable conditions are brought about, but the following seem to be important factors: (*a*) The covering of bean vines protects the tree from the wind, producing a quiet atmosphere in which minute parasitic hymenoptera have an excellent opportunity to live and effect the parasitism of the scales. (*b*) The enclosed space is also likely to be more moist, owing to the presence of the transpiration vapour from the leaves of the limes which are retained under the beans, instead of being immediately dissipated by wind and sun. This damp condition should be favourable to the development of the parasitic fungi which live and develop at the expense of the scales. (*c*) The limes being protected from the sun and wind experience a period of partial rest, resulting from the reduced transpiration and the slower processes of photo-synthesis and growth. (*d*) Still another factor which is strongly suggested by the results obtained so far on plots 1 and 2, is the effect of the rest which the soil experiences during the year that the beans are growing. The soil is not disturbed, there is abundant shelter for insects, and the fine surface roots of the limes are not subjected to any injury from tillage operations.

On the other hand, there is the possibility that Bengal beans may be injurious to the trees by developing too heavy a cover in wet seasons, or on heavy, wet lands, indications of this effect having already been observed. This will probably be overcome by thinning out the bean cover during the wet season by cutlassing a portion or all of the vines, at any time when evidences of injury to the limes are noticed.

Pigeon peas (*Cajanus indicus*) have been grown in lime fields for the purpose of producing soil cover and a green dressing, but the effect of this crop while growing is to dry the soil to such an extent that the practice has been abandoned. Cotton also has been grown in fields of newly planted limes, with the idea that the additional tillage would be beneficial to the limes, but the results have shown that, although one crop of cotton has not been injurious, it has not been of much benefit to the limes, while the growing of two crops of cotton in successive seasons has had a bad effect on the young limes, which it has been extremely difficult to overcome, so that this practice has also been discontinued.

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* *Agricultural News* Vol. VIII, p. 154. The control of Scale Insects in the West Indies by means of Fungoid Parasites. F. W. South, *West Indian Bulletin*, Vol. XI, p. 1.

SUMMARY.

The results obtained from the cultivation plots in Montserrat over a period of three years indicate that clean cultivation and frequent tillage produce vigorous growth, and heavy early bearing. This, however, is offset by the severe attacks of scale insects. The other plots are much alike in the condition of the trees, and in the yields.

The effect indicated by plot 2, that clean cultivation is followed by attacks of scales, seems to be confirmed by the condition of the spineless limes at the Botanic Station, and of the abandoned trees at Richmond. This, however, does not agree with the previously accepted opinion that good, thorough cultivation produces a strong tree capable of withstanding scale insect attacks.

The results also seem to point to a relation between an undisturbed soil cover and the presence of natural enemies, and they raise the question of the possible relation between this method of cultivation and the prevalence of root disease.

It appears that the climatic conditions in Dominica are more favourable to the natural enemies of the scales than in Montserrat, although these are present and capable of exercising a control over the scales, with a little assistance.

The principal scale insect pests of limes are the purple, white and green scales. Under the common name green scale reference has been made to both *Lecanium viride* and *L. hesperidum*, because it is only since 1905 that *L. viride* has been actually known to occur in the Lesser Antilles.

The natural enemies of these insects are of two kinds insects and fungi. The principal insect enemies of scales are the lady-birds, parasitic hymenoptera, and parasitic fungi Of the lady-birds, species of *Scymnus* and *Pentilia* are especially useful. *Cycloneda sanguinea* and *Megilla maculata* feed principally on plant lice (Aphidae), and are not to be counted as o much value in the control of scales, although they are often found on limes.

The purple scale is abundantly parasitized by at least one species of minute hymenoptera, and the purple, white and green scales are all attacked by fungi, of which there are a least four useful species in the West Indies : the red-headed fungus, the black fungus, the shield scale fungus and the white headed fungus, the first three of which are known to occur in Montserrat.

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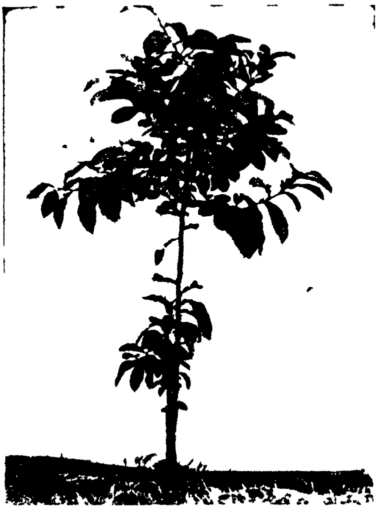
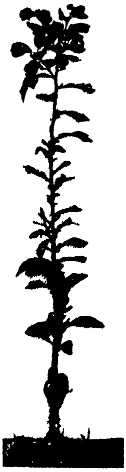
plants were taken out with as much soil as possible adhering to the roots and planted in the holes in the ordinary way. The remaining fifteen trees were dug out without any care, the roots somewhat scarified, and on being planted were well rammed. This was done on July 3, last. The trees carefully transplanted have all along shown themselves to be more healthy, regular and vigorous, and the following measurements, made on June 13, 1910, show the relative size of the trees The soil at Grove is light and sandy in character :—

	Transplanted carefully.					Transplanted carelessly.					
	Average height,		Average width,		Circumference of stem at ground,	Average height,		Average width,		Circumference of stem at ground,
	ft.	in.	ft.	in.	inches.	ft.	in.	ft.	in.	inches.
1	3	6	3	4	4¾	3	0	2	9	4¼
2	3	8	3	6	4¾	3	8	3	0	5
3	3	6	3	0	5½	3	0	3	0	5
4	4	2	3	9	5½	2	0	2	0	3
5	4	0	3	6	4¾	dead		...		...
6	3	3	3	0	4¾	2	0	1	9	2¾
7	3	8	3	0	4¾	3	9	3	4	5
8	3	5	4	0	4¾	3	0	3	3	4¼
9	4	0	3	6	4	dead		..		...
10	3	5	3	6	4¾	3	0	2	8	3½
11	3	9	4	0	5½	dead		...		...
12	3	2	2	6	4	3	6	2	4	4
13	3	4	3	6	5	2	8	2	4	3
14	2	10	3	0	4	3	5	3	6	5¼
15	3	4	4	0	5	3	0	2	6	3
Average	3	6	3	4	4⅘	3	0	2	9	4

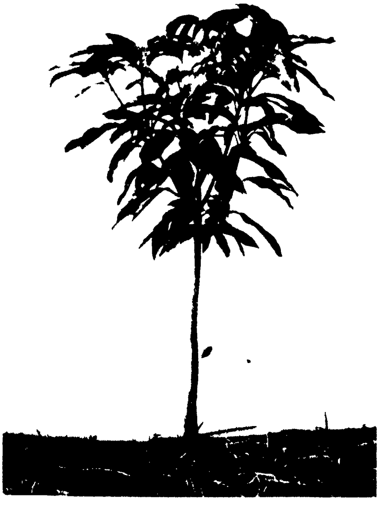
TREE PLANTING EXPERIMENTS, DOMINICA



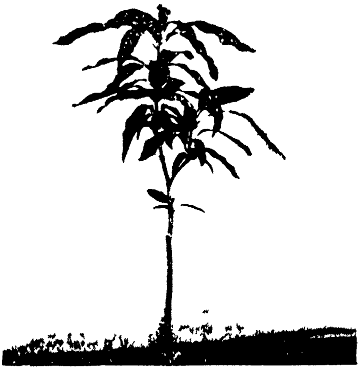
Sour Orange.
(*Orthodox planting*,)



Sour Orange.
(*Woburn planting*)



Mango.
(*Orthodox planting*.)



Mango.
(*Woburn planting*.)

The five plots laid out at Elberton and planted on August 12, 1909, each consisting of fourteen trees, are as follows:—

A. Trees carefully planted according to accepted practice.

B. Trees carefully planted (i.e. roots slightly pruned and carefully arranged in the hole in the usual manner) and the earth rammed hard for a distance of 1 foot round the trees, subsequent to planting.

C. Trees carelessly planted (i.e. roots heavily pruned before planting, and plants inserted in hole without any care) and the earth rammed hard for a distance of 1 foot round the plant, after planting.

D. Trees carelessly planted as in C, but not rammed.

E. Trees carelessly planted. Roots not pruned, and inserted in the hole without care, and the earth round the plant rammed for a distance of 1 foot.

The soil at Elberton is a stiff clay. For some months following the date of transplanting, the trees of A looked greener and a little more vigorous than those of the other plots At the present time, B appears to be slightly in advance of the others, though the difference is very slight. No measurements have been made as yet.

ANTIGUA.

On August 14, 1909, a number of plants of the bay tree (*Pimenta acris*), lime (*Citrus medica*, var. *acida*) and orange (*Citrus Aurantium*) were transplanted from positions in which they were growing and replanted with a view of testing the effect of various methods of planting on the subsequent growth of the trees. The five methods tried were the same as those that have been described for Montserrat.

BAY TREES. The trees used for this experiment consisted of plants about three and a half years old, and plants sixteen months old. The older plants had occupied the position in which they were growing, previous to the time of removing for the experiment in question, for a period of about eighteen months; the younger for about six.

For the A method of planting, four of the older and five of the younger trees were planted. With these there was no appreciable difference in the appearance of either of the two lots for any period after planting. Nor was there any marked contrast in the ability of them to form new growth.

None of the plants lost foliage to any great extent during the first few weeks after transplanting, and their general appearance for the period under review was healthy.

The amount of new growth made by these trees, ten months after planting, was for the four large ones, 17, 11, 9 and 2½ inches, being an average increase in growth of 9·9 inches per tree.

With the younger plants, the growth was far in excess of that made by the above, being 24, 22, 21, 18, and 16 inches, or an approximate growth per tree of 20 inches.

In the B, C, D and E methods of planting, the results obtained were very different from the above.

In B, the same number of each kind of tree was used as in A. Of the older trees, the growth made by one since planting was 5 inches; one has made new growth to the length of from ¼ to ½-inch; and two are dead. Of the younger trees, three of the five planted died, the growth made by the other two since being 12 inches and 3½ inches. All the older trees in C died.

The results given in D were also unsatisfactory. Of the older trees, one made 3 inches growth, one made no growth, and the other died. Of the younger, of which there were five, all, with the exception of one, which is merely alive, are dead.

In E, three of the older trees were used and six of the younger ones. Of these one has made 2½ inches of growth, one has made no growth at all and three are dead.

LIME. At the time of planting trees for these experiments, only four lime trees suitable for this purpose were available. In consequence of this, the method A was not adopted.

In C and E, both plants died.

In B and D, each of the plants died from the top and threw up young shoots, which in the former method obtained a height of 1 foot 11 inches, and in the latter 1 foot 4 inches.

ORANGE. The trees used for these experiments were three years old. Four were employed in each of the A, B, C, D methods of planting and five for E. The average height of these trees was 3 feet.

In A, three trees died outright; one died from the top, but made growth from the base, the length of which is 8½ inches.

In B, all the trees with the exception of one, lived. Of these two withered from the top, but made growth from the base, the length of which is 22 and 16½ inches. The remaining tree made no growth at all.

In C, three died; the remaining one has made growth from the base, the length of which is 6 inches.

In D, two plants died, and two made growth from the base, the lengths being 12 and 16 inches.

In E, three of the trees died, one gained 14 inches and the other 5½ inches in height.

The soil on the plots on which these experiments were conducted is heavy, and poor in organic matter, and plants grown thereon quickly feel the effects of drought.

St. Kitts.

LIMES. Trees of about two years old were planted in rows of five trees each, in the order and manner detailed in the experiments given above, twenty-five trees being used. They were planted on August 16, and were all watered for a few days until some rain fell, when all were left alike.

It was some time before it could be seen if any would survive, but eventually all started to grow, and the only attention given them was to keep them clean of weeds.

When the dry weather set in, many of them died off, and at the present time only six are growing as follows :—

Experiment	A	...	2 trees in good condition.
„	B	...	2 trees in good condition.
„	C	...	All dead.
„	D	...	1 tree in fair condition.
„	E	...	1 tree in poor condition.

Even the best of these trees have not made any progress in growth, being about the same height as when put in. The weather for the past seven months has been exceptionally dry.

It is not considered by Mr. Shepherd that these experiments are very satisfactory, and it is intended, on the advent of wet weather, to start others on the same lines, both in St. Kitts, and if possible, in Nevis.

A broad, general summary of these experiments appears to be that, in the case of Dominica and Montserrat, unorthodox planting has resulted in a decrease of the rate of growth, as might be expected, though it still remains to be seen if this is permanent: while the reports from Antigua and St. Kitts indicate that drought has interfered with the obtaining of results under normal conditions, so that the trials, so far, have been unsatisfactory.

REPORT ON A VISIT TO THE GUANICA CENTRAL SUGAR FACTORY, PORTO RICO.

BY J. R. BOVELL, I.S.O., F.C.S., F.L.S., Superintendent of Agriculture, Barbados; and H. A. BOVELL, Barbados.

Guanica Central Factory, which is the property of the South Porto Rico Sugar Company, is situated on the southern side of that island, and its operations extend from Mayaguez, on the western side, to Amelia, an estate about 10 miles east of Ponce, on the eastern side, that is, a distance of about 80 miles. The factory is near the middle of the district, being 40 miles from Mayaguez and 40 miles from Amelia. The canes are taken to the factory mainly by the American Railway Company's line; in addition, the South Porto Rico Sugar Company possesses about 13 miles of a similar gauge (1 metre) to that of the American Railway Company.

On each estate are loading stations at which the canes are weighed; they are taken to the loading stations by trucks drawn by oxen, running on permanent and portable tram lines, and by ox carts. Each cane waggon holds from 15 to 18 tons of clean canes, and is divided into two compartments. During the day and night, Sunday included when necessary, these waggons are collected and taken to the factory by the railway engines. On the funnels of these engines, a special form of mushroom-shaped spark-arrester is attached, to prevent the ignition by sparks of the fields of sugar-canes along the line. Some of these engines take to the factory at one time as many as 450 tons of cane. At the factory, a small locomotive is kept for removing the empty waggons and putting filled ones into their places.

In addition to a number of estates belonging to the company and leased by it, from which something like 1,000 acres will be cropped this year, canes are purchased from independent growers, known as Colonos, or, as they would be termed in the British West Indian Islands, cane farmers. These colonos, as well as the estates which are worked separately from the factory, are credited with from 5½ to 6 per cent. of the weight of the sugar extracted from the canes, according to the quality of the juice, and paid for on its value in the New York market at the time of its manufacture.

The waggons containing the canes are drawn one at a time into the mill house by a cable attached to a drum of an electric winch. Chains suspended from a strong beam are passed along the inside of the waggons, across the bottoms under the canes and hitched at the side. The canes are then hoisted by an electric winch, attached to a travelling crane suspended over the waggon. While it is thus suspended, the weight of each half car-load is recorded automatically on a ticket inserted into a slot in the weighing machine. The crane is then run over a hopper, and discharged by means of a lever which liberates the hitches in the chains. Along one side of the hopper, an elevator, having curved iron rods on it, takes the canes to the crusher before the mill. There are four of these mills, and for the purpose of keeping an accurate account of their work, extraction, etc., they are designated A, B, C, and D. A is a Fulton Ironworks Cora, 78-inch by 34-inch, twelve-roller mill, with crusher. B is a 72-inch by 37-inch six-roller mill, with crusher; this was not in operation at the time of the visit, as it is only used when more canes are received than the three other mills can crush. C is an 84-inch by 34-inch twelve-roller mill, with crusher, and D is a duplicate of A, that is, a Fulton Ironworks Cora, 78-inch by 34-inch twelve-roller mill, with crusher. All the mills have hydraulic pressure, acting on the top rollers. Water is used for maceration before the feed rollers of the second, third, and fourth mills, and amounts, on the average, to 20 per cent. of the weight of the juice.

The extraction of the juice in the canes, under these conditions, when the six-roller mill was not in use, was from 84 to 86 per cent. of the weight of the canes. The mixed juice from the mills passes through what is called a double-decked strainer. Along the surface of each strainer a scraper elevator runs, removing the particles of fine megass, etc., and dumping them on the megass between the second and third mills. From the end of the strainer, the juice is sent by a bucket elevator to eight weighing tanks, which are 6 feet in diameter and contain, on the average, about 4,000 ℔. of juice. In order that an accurate check may be kept on the results of the crushing of the mills, the tanks are filled with water and weighed daily, so as to ascertain that the scales are recording correctly. The cane scales are also checked every day by means of an unused mill roller of known weight, which is kept on a truck, so that it may be run beneath each scale and weighed. Analyses are being made continually, and every morning the head of each department makes a return to the general manager of the result of the previous twenty-four hours' working, so that, at the beginning of each day, that officer has in his possession the weight of the canes, the weight of the juice and the average analyses of the juice and megass made every four hours for the past twenty-four hours; he can therefore see at a glance whether the mills are extracting the highest possible quanity of juice from the canes, and is in possession of other useful information necessary to the provision of complete control.

Towards the end of the last reaping season, as an experiment, the megass from one of the twelve-roller mills was macerated and passed through the last three rollers of the adjoining mill, and an extra 2 per cent. on the weight of the cane, in juice, was obtained. In consequence of this, the company, which has recently purchased the Fortuna factory, is at present installing there a fifteen-roller mill, with crusher. It may be mentioned here that, at Fortuna factory, the Naudet process had been in use, but at the time of our visit the machinery for this was being discarded so as to make room for the ordinary multiple mills.

From the weighing tanks, the mixed juice is pumped to the liming tanks. On its way to these, milk of lime is run in at the rate of 1 ℔. of lime to a ton of canes, and by means of a small pump a stream of the limed juice passes in an open gutter in front of an operator, who, with a solution of phenolphthalein, contained in a large glass receiver, ascertains whether the juice is sufficiently limed, by dropping a small quantity of the indicator into the limed juice, as it passes before him. In the event of the juice needing more lime, by opening a cock, he increases the quantity, and if he finds it is too great, by partially closing the cock, decreases it. After the juice is limed, it passes to Deming horizontal superheaters, kept at 220° F., and is run from these into absorbers, where the gases and air occluded in the juice escape through a pipe inserted in the top of the vessel. These hot gases are used for heating the juice that comes from the filter presses.

From the eliminators, the juice passes to six Deming separators. These are cylindrical vessels, cone-shaped at the basal end; four of them have a capacity of 12,000 gallons, and two of 10,000 gallons, each. The settlings from these separators are drawn off every twenty minutes, and run into tanks, where by means of cocks at various heights along the sides of the tanks, the clear juice is withdrawn. The residue is run into separate tanks, and after 50 per cent. of water is added, is thoroughly mixed, steamed, and passed through a range of thirty-four filter presses. The clear juice from the Deming separators is sent to the Lillie quadruple evaporators, of which there are three, capable of evaporating 40,000 gallons of mixed juice each, to syrup of 28 to 30 Beaumé, in twenty-four hours. In addition to the Lillie evaporators, there has been recently installed a Kestner climbing film evaporator, but at the time of the visit this was not in operation.

From the evaporators, the juice is pumped into tanks, whence it is drawn by the vacuum pans, of which there are six, two 12½ feet in diameter and four 12 feet in diameter. Each pan contains, when fully charged with massecuite, sufficient to yield about 27 tons of dried sugar per strike. The massecuite from the pans is discharged into the crystallizers and allowed to remain for five hours; it is then run into pug mills and on to the electrically driven centrifugals, of which there are thirty-three. These run at the rate of 1,000 revolutions per minute. The molasses from the first sugar is reboiled; this is done by first graining the pan with syrup and then the molasses, which has been diluted with hot water to 30° Beaumé, is taken into the pan as required. If possible, this is boiled eight hours and then discharged into crystallizers, where it remains for about six days.

The crystallizers are circular vessels, 19¼ feet long by 9 feet in diameter; inside of them there are revolving fans; they are jacketed for steam or cold water. It is estimated that 10 feet of crystallizer space is sufficient per ton of cane crushed per day. As the sugar leaves the crystallizers, it is mixed, by means of an Archimedean screw conveyer, with the first sugars, and taken by a bucket elevator to a receiver, whence it is run into bags resting on small platform scales, weighed, sewn up, and taken to an elevator which conveys it to the sugar store, whence it is shipped direct to vessels, by means of a tram line of about 300 yards.

The mixed sugars have an average polarization of 96°, the first sugar being 97° and the molasses sugars 94°. The molasses from the second sugars, of which there remains about 65 gallons per ton of sugar, is pumped into large tanks and taken by tank steamers to the United States for the purpose of making whiskey. The purity of the residual molasses is about 28 per cent.

With regard to the land supplying canes to the factory, at present there are something like 11,000 acres of canes grown by the South Porto Rico Sugar Company on its own account, in addition to the canes obtained from a large number of colonos. On most estates, there is an admirable system of irrigation. At some of the pumping stations, gasolene engines are used for the motive power ; at others, particularly those in the neighbourhood of the factory, the pumps are operated by electricity ; this is generated at the sugar factory and conveyed by cables to the various stations. Where there is not sufficient rainfall, an effort is made to supply each acre of canes with 50,000 gallons of water every ten days.

The land is almost in every instance either prepared by steam, or bullock-drawn, ploughs. Where the steam ploughs are to be used, as soon as the canes are cut, the fallen leaves are burnt and the land is immediately ploughed, harrowed, and then, by means of double mould-board ploughs, furrowed. The canes are planted in the bottoms of the furrows about 2 feet 6 inches apart. the cuttings being similar to those used in Barbados ; the water, where they are irrigated, is then run along the furrows. As soon as the young canes are about 18 inches to 2 feet high, chemical fertilizers are strewn on the two sides of the clumps, and a small plough drawn by a mule is used to throw some of the soil from the banks on to the stools. Until the canes are too advanced to prevent their use, cultivators are worked on the banks, in order to keep the fields, as far as possible, free from weeds.

MANURIAL EXPERIMENTS WITH COTTON IN THE LEEWARD ISLANDS.

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The position which the industry of growing Sea Island cotton has attained in the Leeward Islands during the past eight years renders experimental investigations into the best method of handling the crop from the point of view of Agricultural treatment of considerable importance.

Manurial experiments with cotton have been carried out in the Leeward Islands since 1904-5, and the results have been published from time to time in the *West Indian Bulletin* (Vol. VI, p. 247 ; Vol. VII, p. 283 ; and Vol. X, p. 269).

In the following, an account is given of further investigations on similar lines carried out during the past season.

The experiments were carried out in triplicate at the experiment Station at La Guérite, St. Kitts, under the supervision of Mr. F. R. Shepherd, Agricultural Superintendent, and on Dagenham estate, Montserrat, under the supervision of Mr. W. Robson, Curator of the Botanic Station.

The manures applied, the yields obtained in each series, and the average return from each experiment are given in Table I.

It is convenient, first of all, to review generally the results obtained, and afterwards to consider in some detail the yields from the different experiments.

Dealing with the results as a whole, it is seen that, in the case of all the series of experiments, with the exception of series III at La Guérite, St. Kitts, the application of manures has in many instances resulted in appreciable increases in yield. Series III at La Guérite was planted at a later date than series I and II ; the effect of the late planting in the third series has been generally to lower the yields, and the check experienced has resulted in nullifying to a large extent the effect of the manures. Consequently, in addition to the average results for all the experiments, the average has been calculated excluding the results from series III at La Guérite, and those together with the differences on the average of the no-manure plots are given in the last two columns of Table I.

Examining these results we find that, out of the first 30 plots, 15 have given increases in yield above the no-manure plot exceeding 100 ℔. of seed-cotton per acre, as a result of the application of manure. These are Nos. 2, 4, 6, 8, 10, 11, 12, 13, 16, 18, 19, 23, 27, 28 and 29.

The largest increase is recorded from plot 18, where one of 311 ℔. of seed-cotton per acre was obtained from the application of 30 ℔. of sulphate of ammonia, 30 ℔. of sulphate of potash and 40 lb. of superphosphate. It is noteworthy that in the case of all the plots which have given increases of more than 100 lb. of seed-cotton per acre, nitrogenous manures in some form have been applied to the plants.

When the results from the individual stations are considered, especial interest attaches to those obtained from the plots at the experiment station at La Guerite, St. Kitts. These experiments have been repeated for six consecutive years, and in each year in each series the same manures have been applied to the same plots. For the supervision of these experiments, Mr. Shepherd has been responsible throughout.

The accumulated results of the threefold repetition under the conditions cited above over a considerable term of years constitute by themselves an investigation of much interest and importance into the agricultural requirements of cotton under the conditions obtaining in St. Kitts.

As has been stated already, it is not customary to plant all three series simultaneously but at different times, in order to obtain information as to the most suitable season for planting cotton. Series I has always been planted earliest, while series III has been the last established; the results from these experiments have conclusively proved that, as far as the conditions in St. Kitts are concerned, late planting gives decreased yields. Reference to the earlier published results referred to above will render this point abundantly clear, for the yields from the plots in series III have consistently been lower than those from series I and II planted during the earlier months. As a result, it can be laid down with some confidence that, in localities in St. Kitts where the conditions approximate to those obtaining at the La Guerite experiment station, it is essential, under average conditions of rainfall, that cotton should be planted not later than July, in order to obtain the best results.

Turning to the results obtained for the application of manures, and examining these from those sets of experiments carried out during the past season, one finds that, in the case of the three plots in series I and II, in many instances notable increases of yield have followed the application of the manures; this however does not apply to series III, but as was stated above, the unfavourable conditions resulting from the latter planting have probably prevented the manures from exercising their full effect.

The chief increases of yields, in the first 30 plots, have been recorded from the following plots: No. 4, No. 6, No. 8, No. 10, No. 11, No. 13, No. 16. No. 18, No. 19, No. 23, No. 27, No. 28, No. 29. These results do not show any very striking characteristics except that in all these cases where nitrogenous manures have been added, in no case has application of manures without nitrogen produced a profitable increase in either series I and II.

The most striking feature in the La Guerite series of experiments, however, is that the present season is the first during the whole period over which the experiments have been conducted that application of manures has produced marked increases of yield over that from the no-manure plot. This is well shown in Table II, in which are given the average returns from series I and II*, over the whole six years during which the experiments have been carried on; examination of this table reveals the fact that with one single exception, applications of manures have not yielded appreciable increases. The single exception is in the case of plot 11, in which 20 lb. of nitrogen as nitrate of soda has yielded an increase, on the average, of 130 lb. of seed-cotton. Assuming the value of lint to be 1*s*. 6*d*., per lb., the cost of nitrate of soda to be £13 per ton, its nitrogen content to be 15 per cent., and the yield of lint to be 25 per cent., this application has yielded a profit of 31*s*. 6*d*. How much weight should be attached to these results is not clear, for in the case of experiment No. 12, in which nitrate of soda alone was applied, at the rate of 30 lb. per acre, the increase of yield experienced was lower than that in the case of plot 11.†

As a result, therefore. of six years' continuous work, in which the same manures have been applied to the same plots, the following striking result is obtained: that, under the conditions obtaining at the experiment station at La Guérite, St. Kitts, application of manures to Sea Island cotton has with possibly one single exception, not only failed to increase the yield, but in many instances has led to actual decreases.

It may be added that, prior to the inception of the experiments, the land had been planted in canes for many years, and that since this time the plots have received no manures whatever, except those applied experimentally; neither have any green dressings been grown, nor has the soil been enriched in any way, by the addition of organic matter.

It would appear that, under the conditions of the experiment, in the past the natural plant food reserves in the soil have been sufficient to meet the manurial requirements of the crop. As a result of this continuous cropping, it would seem that the no-manure plots are at last showing signs of exhaustion, and the future results of the experiments will be awaited with interest.

The position with regard to the no-manure plots in the La Guérite experiments presents an investigation of conditions not parallel in experiments carried out in the other Presidencies since, on these plots, cotton has been grown continuously during a period of six years without application of manure, and without suffering appreciable diminution of yield, in consequence. It is not possible, at present, to say whether the cotton-growing soils in other islands of the Leeward Islands group would be able to produce cotton under similar conditions for equal lengths of time, since it is only in the case of the La Guérite experiments that the data are available.

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* On account of the ill effect resulting from late planting, the returns from series III have not been included in the average.

† The apparent discrepancy between the results in plots 11 and 12 may possibly be explained by the consideration that neither of the increases is beyond the limits of a 10-per cent. experimental error, so that they do not give any indication that manuring has led to an increase of yield. [Ed. *W.I.B.*]

The average results for the entire series of experiments, covering a period of six years and including individual experiments in St. Kitts, Nevis, Montserrat and Antigua are given in Table III; they show that in no single instance are appreciable increases of yield traceable to the application of manures. The result gives no cause for altering the opinion laid down in the last report laid down on these experiments (*West Indian Bulletin*, Vol. X, p. 273), namely that under conditions obtaining in the Leeward Islands with soils in moderately good tilth, the application of natural and artificial manures is unremunerative.

It is not however suggested that the application of natural manures and the growth of green dressings for the purpose of the maintenance of tilth are not from time to time desirable; on the contrary, it is believed that such periodic applications are essential for the successful carrying on of all cultural operations.

TABLE
MANURES AND YIELDS

No. of Experiment.	Nitrogen as nitrate of soda.	Nitrogen as sulphate of ammonia.	Potash as sulphate of potash.	Phosphoric acid as basic phosphate.	Cotton seed meal.	Salt.	Sulphate of copper.
1	...	...	No manure		...	...	...
2	...	...	Pen manure		...	...	...
Nitrogen Series.							
3	...	...	30	40	...	...	...
4	...	20	30	40	...	...	...
5	..	30	30	40	...	...	...
6	20	...	30	40	...	...	...
7	30	...	30	40	...	...	...
8	...	30	30	..	...	...	...
9	..	20	...	...	...	..	...
10	..	30	...	...	..	...	...
11	20	...	...	...	...	...	...
12	30	...	...	...	...	..	...
Phosphate Series.							
13	...	30	30	...	...	...	...
14	...	30	30	40	...	...	...
15	...	30	30	60	...	..	...
16	...	30	30	80	...	...	...
17	...	...	...	40	...	...	...
18	...	30	30	40*	...	...	...
19	...	30	30	60*	...	...	..
Potash Series.							
20	...	30	...	40	...	...	...
21	...	30	20	40	...	...	...
22	...	30	30	40	...	...	...
23	...	30	40	40	...	...	...
24	...	...	40	...	...	...	...
Cotton Seed Meal Series.							
25	...	...	...	...	300	...	...
26	...	...	...	...	600	...	...
27	...	...	30	...	300	...	...
28	...	...	...	40	300	...	...
29	...	...	30	40	300	...	...
30	...	30	30	40	300	...	...
Salt Series.							
31	...	...	...	...	...	100	...
32	...	...	...	...	...	200	...
33	...	30	30	40	...	100	...
34	...	30	30	40	...	200	...
35	...	...	...	...	300	100	...
Sulph. of Copper Series.							
36	...	...	...	...	...	...	20
37	...	30	30	40	...	...	20
38	..	...	...	...	300	...	20

* Phosphoric acid as superphosphate.

I.
IN POUNDS PER ACRE, 1909.

La Guérite.			Montserrat.	Average.	Difference on No manure.	Average of all Stations except LaGuérite No. III.	Difference on No manure.
I.	II.	III.					
1,507	1,495	1,120	1,168	1,322	...	1,390	...
1,600	1,570	1,116	1,365	1,413	+ 91	1,512	+122
1,467	1,620	1,000	1,103	1,298	– 24	1,397	+ 47
1,920	1,740	1,400	1,100	1,540	+218	1,587	+197
1,640	1,360	1,086	1,323	1,352	+ 30	1,441	+ 51
1,647	1,900	950	1,224	1,430	+108	1,590	+200
1,520	1,470	1,260	1,139	1,347	+ 25	1,376	– 14
1,747	1,660	1,190	1,344	1,485	+163	1,584	+194
1,400	1,550	1,070	1,203	1,306	– 16	1,384	– 6
1,740	1,800	880	1,394	1,454	+132	1,645	+255
1,780	1,696	1,050	1,194	1,430	+108	1,557	+167
1,600	1,910	900	1,098	1,377	+ 55	1,536	+146
1,747	1 660	1,190	1,344	1,485	+ 63	1,584	+194
1,640	1,360	1,080	1,323	1,351	+ 29	1,441	+ 51
1,760	1,290	1,140	1,268	1,365	+ 43	1,439	+ 49
1,820	1,610	1,255	1,189	1,469	+147	1,540	+150
1,680	1,450	1,100	1,287	1,379	+ 57	1,472	+ 82
2,060	1,670	960	1,373	1,516	+194	1,701	+311
1,767	1,680	740	1,180	1,342	+ 20	1,542	+152
1,380	1,690	980	1,334	1,346	+ 24	1,468	+ 78
1,440	1,730	710	1,210	1,272	– 50	1,460	+ 70
1,640	1,360	1,080	1,326	1,351	+ 29	1,441	+ 51
1,720	1,740	990	1,275	1,431	+109	1,578	+188
1,545	1,480	960	1,214	1,300	– 22	1,413	+ 23
1,860	1,485	930	1,118	1,348	+ 26	1,488	+ 98
1,700	1,540	900	1,126	1,316	– 6	1,455	+ 65
1,732	1,720	1,100	1,210	1,440	+118	1,554	+164
2,030	1,800	1,050	1,203	1,521	+199	1,678	+288
1,827	1,770	1,030	1,040	1,417	+ 95	1,546	+156
1,787	1,390	1,040	1,283	1,375	+ 53	1,487	+ 97
1,360	1,290	1,010	..	1,220	–102	1,325	– 65
1,260	1,520	980	...	1,253	– 69	1,390	...
1,620	1,700	845	...	1,388	+ 66	1,660	+270
1,707	1,300	1,020	..	1,342	+ 20	1,503	+113
1,980	1,550	930	...	1,487	+165	1,765	+375
1,680	1,820	880	...	1,293	– 29	1,500	+110
1,485	1,870	820	...	1,375	+ 53	1,652	+262
1,667	1,480	660	...	1,269	– 58	1,578	+188

TABLE II. LA GUERITE. SERIES I AND II.

MANURES AND YIELDS IN POUNDS PER ACRE.

Mean of six years—38 plots.

No. of Experiment.	Nitrogen as nitrate of soda.	Nitrogen as sulphate of ammonia.	Potash as sulphate of potash.	Phosphoric acid as basic phosphate.	Cotton seed meal	Salt.	Sulphate of copper.	Seed-cotton.	Difference on No manure.
1	...	..	No manure		..	...	...	1,348	...
2	..	...	Pen manure		...	...	...	1,397	+ 49
Nitrogen Series.									
3	...	...	30	40	...	..	...	1,290	- 58
4	..	20	30	40	...	...	...	1,397	+ 49
5	...	30	30	40	...	...	...	1,300	- 48
6	20	...	30	40	...	...	...	1,404	+ 56
7	30	...	30	40	..	..	...	1,232	- 116
8	...	30	30	...	..	...	..	1,352	+ 4
9	...	20	...	...	...	...	..	1,158	- 90
10	...	30	..	...	...	...	...	1,347	- 1
11	20	...	..	...	...	...	...	1,478	+ 130
12	30	..	..	...	...	..	..	1,426	+ 78
Phosphate Series.									
13	..	30	30	...	...	...	...	...	...
14	...	30	30	40	...	...	...	...	...
15	..	30	30	60	...	..	..	1,375	+ 27
16	...	30	30	80	...	...	..	1,420	+ 72
17	...	...	..	40	...	...	...	1,296	- 52
18	...	30	30	10*	...	...	...	1,350	+ 2
19	.	30	30	60*	..	...	...	1,272	- 76
Potash Series.									
20	...	30	...	40	...	...	..	1,260	- 88
21	...	30	20	40	...	...	...	1,195	- 153
22	...	30	30	40	..	...	...	..	...
23	...	30	40	40	...	...	...	1,315	- 33
24	...	...	40	...	...	...	...	1,284	- 64
Cotton Seed Meal Series.									
25	...	...	...	...	300	...	..	1,370	+ 22
26	...	...	...	...	600	...	.	1,426	+ 78
27	...	...	30	...	300	.	...	1,396	+ 48
28	...	..	...	40	300	...	...	1,410	+ 62
29	...	...	30	40	300	...	...	1,295	- 53
30	...	30	30	40	300	...	...	1,379	+ 31
Salt Series.									
31	..	...	...	...	...	100	...	1,146	- 202
32	..	...	...	...	...	200	...	1,188	- 160
33	..	30	30	40	...	100	...	1,266	- 82
34	...	30	30	40	.	200	...	1,150	- 198
35	...	...	...	...	300	100	...	1,217	- 131
Sulph. of Copper Series.									
36	...	...	...	...	...	...	20	1,198	- 150
37	...	30	30	40	...	...	20	1,200	- 148
38	...	...	...	...	300	...	20	1,212	- 136

* Phosphoric acid as superphosphate.

TABLE III. ALL STATIONS.

MANURES AND YIELDS IN POUNDS PER ACRE.

Mean of six years—37 plots.

No. of Experiment.	Nitrogen as nitrate of soda.	Nitrogen as sulphate of ammonia.	Potash as sulphate of potash	Phosphoric acid as basic phosphate	Cotton seed meal.	Salt.	Sulphate of copper	Seed-cotton.	Difference on No manure.
1	...	...	No manure		.	..	..	944	...
2	...	...	Pen manure		...	...	...	985	+ 41
Nitrogen Series.									
3	..	...	30	40	...	..	...	951	+ 7
4	...	20	30	40	...	..	..	972	+ 28
5	..	30	30	40	...	..	...	994	+ 50
6	20	...	30	40	..	...	..	957	+ 13
7	30	..	30	40	.	...	...	943	- 1
8	..	30	30	. .	...	...	...	985	+ 41
9	.	20	...	..	...	..	...	895	- 49
10	...	30	...	...	...	. .	.	1,009	+ 65
11	20	...	.	...	..	...	..	998	+ 54
12	30	...	...	...	...	...	...	958	+ 14
Phosphate Series.									
13	...	30	30	..	...	...	...	985	+ 41
14	...	30	30	40	...	...		994	+ 50
15	.	30	30	60	...	.	...	946	+ 2
16	...	30	30	80	...	...	...	976	+ 32
17	..	. .	...	40	...	...	..	925	- 19
18	..	30	30	40*	..	...	...	939	- 5
19	...	30	30	60*	..	...	..	887	- 57
Potash Series.									
20	..	30	...	40	...	..	...	919	- 25
21	...	30	20	40	..	..	...	847	- 97
22	..	30	30	40	..	...	...	994	+ 50
23	...	30	40	40	.	..	...	903	- 41
24	...	...	40	..	...	...	...	929	- 15
Cotton Seed Meal Series.									
25	...	...	...	...	300	...	...	927	- 17
26	...	...	.	..	600	...	...	924	- 20
27	..	...	30	..	300	...	..	937	- 7
28	...	...	...	40	300	...	...	991	+ 47
29	...	...	30	40	300	...	...	899	- 45
30	...	30	30	40	300	...	...	897	- 47

* Phosphoric acid as superphosphate.

THE ROOT DEVELOPMENT OF COTTON PLANTS IN DIFFERENT SOILS.

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The results obtained from the experiments in the manuring of cotton prompted the enquiry as to whether any relationship was traceable between the root development of cotton plants and the character of the soils on which the plants were grown, with the idea that possibly some light might be shed thereby on the manurial requirements of the crop.

Cotton is essentially a tap rooted plant, that is to say, in its root development the natural tendency is for it to send one main root more or less vertically downward in the soil from which the lateral roots take their origin as offshoots.

A number of cotton plants were carefully dug up in the cotton fields in St. Kitts, Nevis, Montserrat and Antigua and their root systems examined in order to endeavour to obtain information on this point; in doing so, care was taken to avoid injury to the root system as far as possible.

The plants examined were all matured bushes which had ripened a crop of cotton, and of which the root system was fully developed. They were obtained as follows : —

St. Kitts: 1 plant from a field near the Botanic Station, Basseterre ; 2 plants from the experiment plots at La Guérite, 2 plants from a field of cotton near the La Guérite experiment station.

Nevis : 9 plants from the experimental field of cotton adjoining the experiment station.

Montserrat : 3 plants from Dagenham estate, 2 plants from Gages estate.

Antigua : 3 plants from the experiment plot at the Skerretts experiment station.

The results of the examination of these plants is given in the accompanying table in which are shown the maximum length attained by the tap root ; the maximum length attained by the lateral roots ; the circumference of the stem at the soil surface ; the total number of main lateral roots developed from each stem, together with general remarks on the plants.

An examination of these results will show that in the case of the St. Kitts plants, the main characteristic is the profuse growth of lateral roots which has taken place, and also the fact that the root range is more extensive than elsewhere. This is shown to a lesser extent by the Montserrat plants while, as a contrast, in those from Nevis, relatively little lateral root development has taken place.

The effect is most markedly seen when the root system of the plants from the different localities are examined, for while in the case of the St. Kitts plants, and also the Montserrat to a large extent, the development of lateral roots is profuse and presents numerous offshoots which nearly equal in thickness the tap root itself, in the case of the Nevis cottons which present the greatest contrast, the main root development is in the tap root which is often of remarkable thickness, tapering down as the root penetrates the soil, while lateral offshoots are almost invariably thin and stringy.

The characteristics of the St. Kitts soils are their lightness and depth, the sand and silt constituents predominating greatly over those of those classed as clay. This is shown in the following physical analysis of the soil from Buckleys estate which adjoins, and is similar to that of the locality from which the plants were taken :—

Stones	6·5	Very fine sand	2·4
Coarse gravel	10·5	Silt	5·0
Gravel	23·7	Fine silt	12·1
Coarse sand	14·8	Clay	1·3
Medium sand	18·9		
Fine sand	2·3		

The soil of the experiment plot in Nevis is, on the contrary, much heavier in character; reference to a paper on the soils of Nevis, *West Indian Bulletin*, Vol. X, p. 60, will make this clear. It is however probable, that the soil in the parts of the plot from which plots 7, 8 and 9 were taken contains rather more of the clay constituents than appears in the analyses there given.

At Dagenham and Gages, Montserrat, the soil is, on the whole, fairly light, and approximates to St. Kitts conditions; this is shown by reference to the paper on the Soils of Monsterrat (*West Indian Bulletin*, Vol. VI, p. 263). The conditions at Dagenham approximate closely to those at the Grove estate, and the analyses for this station may be assumed as fairly representative of the conditions. It will be seen that the soil at Gages is distinctly closer in texture than that at Dagenham.

The conditions at the experiment plot at Skerretts, Antigua, are peculiar. The soil is typically a stiff heavy clay, very difficult to work.

Continued cultivation and manuring have produced in the upper layer a condition of very high tilth particularly favourable to the growth of crops ; as a result of this, the tendency of the cotton plants has been to form a root system with thick branching lateral roots, all of which are confined to the upper layers of the soil.

GROWTH OF COTTON ROOTS IN DIFFERENT SOILS.

Locality.	No. of Plant.	Length of tap root.	Max. lateral root.	Circumference of stem at soil surface.	Total No. of main lateral roots.	Remarks.
		Inches.	Inches.	Inches.		
St. Kitts	1	48	36	3	12	Some of main lateral roots very thick and much branched.
La Guérite	2	24	33	2	6	As in 1.
	3	24	32	2	8	” ” ”
	4	26	24	3¼	12	” ” ”
	5	19	46	3	9	” ” ”
Average		20·2	34·2	2·65	9·4	
Nevis light soil	1	17	24	3⅛	6	Lateral roots slender and very little branched. Tap root very thick.
Experiment Plot	2	7	30	2⅞	6	As in 1.
	3	6	36	2	7	” ” ”
	4	18	20	3½	6	” ” ”
Medium	5	6	29	2⅞	7	Lateral roots all confined to one side of plant.
	6	8 or 52	19	3¼	9	” slender and very little branched. Tap root bifurcated.
Heavy soil	7	23	32	3½	7	Lateral roots slender and very little branched. Tap root very thick.
	8	8	36	3⅛	5	As in 7.
	9	12	30	3⅞	12	” ” ”
Average		11·6 or 16·5	28·4	3·1	7·2	
Montserrat	1	30	30	...	12	Profuse development of lateral roots and rootlets. Some of main laterals very thick.
Dagenham	2	18	24	...	8	As in 1.
Gages	3	23	21	...	8	Tap root three-pronged and branching laterally to a large extent.
Gages	4	23	28	...	5	As in 3.
Dagenham	5	20	30	...	11	Profuse development of lateral roots and rootlets.
Average		22·8	26·6	...	8·8	
Antigua	1	22	34	2¾	4	Lateral roots fairly thick and confined on the whole to region near soil surface.
Skerretts	2	14&12	26	2¾	10	As in 1. Tap root bifurcated.
	3	24	48	3½	7	As in 2.
Average		20	36	3	7	

From the foregoing results it will be seen that the form taken by Sea Island cotton in respect to its root development, varies considerably according to the character of the soil in which it is planted. In light, deep, open soils, the root range is, on the whole, decidedly more extensive and the development of the lateral roots heavier and more profuse than in the case in soils heavier and more clayey in character. The character of the root development would also appear to be influenced to some extent by the tilth of the soil in which the plant is grown.

The suggestion is made that the more extended root range in light soils renders available to the plant supplies of plant food which it could not otherwise make use of; hence under such conditions, crops of cotton may possibly be capable of being grown without manure for relatively longer periods of time, than under conditions which do not permit of such extensive root range.

(Pages 1 to 71 issued September 20, 1910.)

REPORT ON THE PREVALENCE OF SOME PESTS AND DISEASES IN THE WEST INDIES, FOR THE YEAR 1909-10.

PART I.—FUNGOID DISEASES.

BY F. W. SOUTH, B.A. (Cantab.),
Mycologist on the Staff of the Imperial Department of Agriculture for the West Indies.

In order to ascertain the general prevalence and distribution of plant diseases during the year 1909-10, a form containing a list of the principal diseases of crops cultivated in the West Indian islands was sent to each of the agricultural officers at the beginning of June 1910. This was accompanied by a covering letter, in which it was requested that each officer would fill in the part relating to those crops which came under his observation, and would return the forms, when so filled in. It was further indicated that attention should be paid mainly to the general prevalence of the diseases, and to any important attacks of local occurrence. The present article is summarized from these reports.

SUGAR-CANE DISEASES.

ROOT DISEASE (*Marasmius* sp.).

Barbados.—This fungus was very prevalent all over the island and in some cases did a great deal of injury.

St. Vincent.—The disease was seen in most fields. The extent of the damage caused by it was uncertain.

St. Lucia.—There were no special diseases reported from the sugar estates.

Dominica A severe outbreak was reported from one estate, and it was also prevalent on others. The Bourbon cane seemed particularly prone to attack.

Montserrat. -It was very prevalent where cane was grown (H. A. Tempany, in report on Antigua).

Antigua. The disease was very prevalent throughout.

St. Kitts. It showed itself in places, chiefly on the ratoon crops, but there was no wide-spread attack The necessity of remedial measures is fairly generally recognized, those employed consisting of the digging out and burning of the stumps and the application of lime to infected areas.

Nevis.—It occurred in some localities, but not to any serious extent; the attack is always more serious in ratoon fields than in those containing plant canes.

It will be seen from the information given above that this disease is of very wide-spread occurrence and undoubtedly of a serious nature, particularly in Barbados and Antigua. Although it has been known for a considerable time and its importance frequently pointed out, it is to be feared that the extent of the damage which it is capable of causing, more especially in a dry season, is not yet fully recognized by some planters.

Much might be done in checking this disease if remedial measures were employed generally on all estates on which sugar forms the principal crop. These should consist of the breaking, up of the stools and their exposure to the sun and air as soon after the reaping of the crop as possible. It would be better if they were burned, as is described for St. Kitts. This procedure should be carried out in connexion with a suitable rotation crop such as cotton, or a leguminous green dressing.

RIND DISEASE (*Trichosphaeria sacchari*, Massee).

Barbados.—This is always present on dead canes which are dry

St. Vincent.—It occurred to a considerable extent, but chiefly in fields of the Bourbon variety of canes.

Antigua.—The fungus was not prevalent, but cases were somewhat more frequent than formerly. It was often noticed in fields badly attacked by root disease.

St. Kitts.—It was not observed to any extent.

Nevis.—It was observed on some estates. The statement is made that the seedling cane B. 147 was always more subject to attacks than any other variety.

The true relative significance of the fungi associated with the West Indian rind disease of the sugar-cane is still a matter of doubt and no definite statement can be made on the subject, any discussion on the evidence even, being out of place in a paper of this nature. It suffices to state that at present no very definite distinction is recognized generally, by those connected with agriculture, between the occurrence of *Trichosphaeria* *sacchari* and of *Colletotrichum falcatum* on the sugar-cane. This accounts for some imperfection in the records given and renders those concerning the latter fungus in particular somewhat unreliable, the probability being that it occurs in all the sugar-growing islands, though its presence is not definitely recognized independently of that of *Trichosphaeria sacchari.*

Taking into consideration the very serious damage once attributed to this disease, it cannot now be said to be of any very great importance. It should, however, be borne in mind that the damage inflicted on the Bourbon canes occurred quite suddenly and that the disease, whatever its fungoid cause, must have been present previously, to a small extent, for some considerable time. For this reason, the prevalence of fungoid disease in the principal sugar-growing islands should always be watched with care, in order that steps may be taken in time to prevent a repetition of the former disaster. In this connexion, the susceptibility of B. 147 to rind disease in Nevis is worthy of note.

The association of the rind disease with root disease in Antigua is significant, and emphasizes the importance of undertaking remedial measures to control the latter.

RED ROT DISEASE (*Colletotrichum falcatum*, Went).

Barbados.—This is always more or less present in the Bourbon cane and was much in evidence in 1909. It was not observed on any other variety in that year.

Antigua.—It appeared to be somewhat on the increase.

No occurrences of this disease are recorded from any of the other islands in the Leeward or Windward groups. As has been pointed out already, the absence of any record of the occurrence of this fungus in the other islands may be due to confusion between it and *Trichosphaeria sacchari*, to which the majority of the damage inflicted on the cane stems is most commonly attributed by planters.

COTTON DISEASES.

ANTHRACNOSE (*Colletotrichum gossypii*, Southworth).

Barbados.—This was practically absent during 1909.

St. Vincent.—It was observed in all fields and did a considerable amount of damage on four estates.

St. Lucia.— It was observed to be present to a small extent at Gros Islet. It was also reported to be present to a more serious extent on the later portion of the crop at Choiseul.

Antigua.—Outbreaks of a disease which appeared to be anthracnose are reported to have been of not uncommon sporadic occurrence.

Nevis.—It was seen in some localities but practically no damage was done by its attacks. It was generally confined to damp districts.

In *Mycologia*, Vol. I, p. 115, an account is given by C. W. Edgerton of the perfect or ascigeral stage of the same fungus causing anthracnose of cotton in the United States. It consists of numerous, crowded, small perithecia, dark-brown to black in colour, which are buried in the tissue of the host with only the beaks protruding. The ascospores are of a moderate size, nearly elliptical, granular, hyaline and unicellular. In addition to the asci, the perithecia contain numerous long, slender paraphyses filling the entire cavity. The fungus belongs to the genus Glomerella, and should now be known as *Glomerella gossypii*, Edgerton. From a local point of view, it is worthy of note that the damage done by this disease is often confused with that caused by the bacterial boll disease. Consequently, the importance of the latter is frequently overlooked.

BACTERIAL BOLL DISEASE.

Barbados.—It was very prevalent, and caused many bolls to drop.

Montserrat.—It was widely distributed, though it did not appear to affect the crop seriously.

Antigua.—It was observed to some extent in damp situations.

Nevis.—The disease was not observed as such, but dropping of bolls was very prevalent during the damp season.

This disease was only investigated during September 1909, and consequently, its characteristic features are not as yet widely recognized. As a result of this, the disease is often confused with anthracnose, and records of its occurrence are of a somewhat uncertain nature, except in the case of those received from Barbados and Montserrat. It is probable that the disease is due to the same organism as that causing angular leaf spot of cotton. If this should prove to be the case, the bacterial boll disease will probably be found somewhat difficult of control, owing to the almost universal occurrence of angular leaf spot. Consequently, the latter must be regarded as being of considerably more importance than was formerly thought to be the case. (See *Agricultural News*, Vol. IX, p 166.)

ANGULAR LEAF SPOT (*Bacterium malvacearum*).

Barbados.—This disease was very prevalent. The Rivers variety of Sea Island cotton, which is practically the only variety grown in Barbados, is recorded by Orton as rather susceptible to this disease. (*Farmers' Bulletin* 302, U. S. D. A.)

St. Vincent.—It was seen in most fields but was particularly bad on one of the estates where anthracnose, so called, was also reported to be fairly prevalent.

St. Lucia.—It is reported as occurring for the most part when the crop is in an advanced state.

Antigua.—It was recorded, in moist situations, as of sporadic occurrence.

Nevis.—It was present in almost all parts of the island where cotton was grown. Regarded as a leaf disease only, it does not appear to do any appreciable damage to the crop.

When occurring on the leaf this disease does not inflict any very serious damage ; its main importance is its probable connexion with the bacterial boll disease, as has been already pointed out.

Its prevalence in St. Vincent, on one of the same estates as was much affected by anthracnose, is somewhat significant, when it is considered that, in all probability, much of the damage on that estate which was attributed to anthracnose was in reality due to bacterial boll disease.

WEST INDIAN LEAF MILDEW.

Barbados.—There was but little of this present during 1909.

St. Vincent.—It was seen in all localities. The attack was severe in districts where the rainfall was heavy.

Antigua.—It was noticed, but no severe attack was recorded.

St. Kitts.—It was observed in a few instances, but was not sufficiently common to cause any serious damage or call for treatment.

Nevis.—There was practically none of this disease in 1909, but it was very prevalent in 1907, especially in damp parts, and after heavy rains.

This disease would not seem at present to be of any serious importance, except in the possible event of a very wet season, as its attacks appear to be confined to moist localities. These observations are of value, as very little was previously recorded as to its general distribution and importance.

CACAO DISEASES.

ROOT DISEASE.

Grenada.—Sporadic cases were noticed, but there was no general attack. The treatment applied, which consists in the entire removal of the trees, with subsequent liming of the soil, was apparently effective in checking the disease.

St. Lucia.—The distribution of this disease is fairly general, though it was mostly observed on bottom land orchards. Attacks associated with die-back occurred on two estates.

Dominica.—The disease is reported from the Government plot, Riversdale.

No instances of this disease are reported from the other cacao-growing islands. It is interesting to note that the disease is not prevalent in Grenada and that the remedial measures appear to have been effective.

CANKER.

St. Vincent.—Isolated trees with canker were seen on most estates.

Grenada.—On the whole, the disease was not common. Remedial measures are promptly taken on its first appearance, sometimes with success. These consist of excising the diseased tissues and tarring the resultant wounds. Where cacao is closely planted, bad cases appear and some trees are entirely destroyed.

St. Lucia.—It was common and doing some damage on many estates. The worst cases occurred on bottom land, as far as the observations went.

Dominica.—It was especially prevalent on the more delicate varieties of cacao.

St. Kitts.—It was observed attacking one or two trees. The remedies used were the cutting out of diseased parts and careful tarring of wounds.

This disease is still of considerable importance in the principal cacao-growing islands, with the exception of Grenada. In Dominica in particular it is prevalent upon all the more delicate varieties of cacao, and repeated attempts to check the disease have shown that, in general, remedial measures are unsuccessful in the case of these varieties, as they appear to be unable to heal over the wounds made in excising the diseased tissues (*West Indian Bulletin*, Vol. X, p. 340). It is also worthy of note, that the grafted Alligator cacao at the Botanic Station was very prone to attacks of this disease. (Loc. cit., p. 341, and Botanic Station Report, Dominica, 1909-10). Rorer, in Trinidad, has recently shown that it is in reality due to the same fungus as causes Black Rot of the pod (*Phytophthora* sp.) Investigations are being undertaken with a view to determining if the same fungus is responsible for the disease in Dominica. Up to the present, however, no very conclusive results have been obtained. (Rorer. *Bulletin of the Department of Agriculture*, Trinidad, Vol. IX, p. 79.)

DIE-BACK AND STEM DISEASE (*Lasiodiplodia theobromae*, Griffon and Maublanc).

St. Vincent.—It was present, but was not of a serious nature.

Grenada.—One case of die-back was noted. It is suggested that the disease was mainly due to neglect. Drainage, pruning and tillage were recommended as remedies by the agricultural officers.

St. Lucia.—It is common throughout the island. Mr. Moore remarks: 'This disease is either becoming worse, or is more frequently recognized than formerly.'

Dominica.—Die-back was reported from one or two localities, on young cacao.

The observations from St. Lucia on this disease are worthy of note. The causative fungus would appear to be of very frequent distribution, probably upon several different host plants, throughout the whole of the West Indies. In the earlier stages of its attack, when the disease is known as die-back, remedial measures should prove effective; but there is reason to fear that once the fungus has obtained a firm hold on the main branches and stem, there is very little that can be done to save the tree. Under these circumstances, it will probably be found that the cheapest course is to destroy the diseased trees as thoroughly as possible. Careful attention to the sanitation of cacao orchards, possibly in combination with intelligent applications of fungicides, especially spraying with Bordeaux mixture, would most probably be found to reduce the disease greatly.

BROWN ROT OF PODS (*Lasiodiplodia theobromae*, Griffon and Maublanc).

St. Vincent.—There were a few isolated examples, but the disease was not very prevalent.

Grenada.—There were no general outbreaks and but few individual cases of this disease. Precautions, such as the burial of pods, and general attention to sanitation are usually employed, and their use is increasing.

St. Lucia.—The disease was present, but it is uncertain as to what extent.

Dominica.—It was to be seen now and again on most estates.

It is probable that the employment of preventive measures in Grenada, with a view to controlling this disease, may account to a considerable extent for the rare occurrence of die-back and stem disease in that island, decaying remains of cacao pods being one of the most common food supplies for the fungus.

BLACK ROT OF PODS (*Phytophthora* sp.)

St. Vincent.—It was seen in all fields. There appeared to be a good deal of this disease everywhere.

St. Lucia. It was present, but it is uncertain to what extent.

Dominica.—It was occasionally noticed on estates.

This disease is worthy of attention, more particularly if it should prove that the causative fungus is also responsible for canker. (Rorer. *Bulletin of the Department of Agriculture*, Trinidad, Vol. IX, p. 79.)

PINK DISEASE (*Corticum lilacino-fuscum*, B. and C.).

St. Lucia.—It was reported from two estates, but was controlled by the use of lime-sulphur wash. (*West Indian Bulletin*, Vol. IX, p. 179.)

Dominica.—It was observed on one estate only, and was not regarded as being of a serious nature.

This disease has never appeared to be of much importance as regards cacao, but some authorities believe that the fungus which causes it is identical with *Corticium javanicum*, Zimm., which inflicts serious damage on Hevea, Castilloa and other plants, in the East. (*Agricultural News*, Vol. IX, pp. 286 and 318.) For this reason, care should be taken to prevent the spread of pink disease from cacao to Hevea, in those islands where the latter has been introduced.

THREAD BLIGHTS.

Grenada.—These were found in 1910, and officially reported. According to popular rumour, they were noticed in 1909 and previously.

Fungi of this nature are reported on several host plants from different parts of the world, and are very probably representative of several different species. In addition to cacao, this disease has been found on nutmegs in Grenada.

HORSE-HAIR BLIGHT (*Marasmius equicrinis*, Müller).

Grenada.—A root fungus, which appears to be in some way connected with this disease, has attacked cacao, coffee, breadfruit, bananas and small weeds, at one estate in the mountains. The actual cause of this disease is, however, still under investigation.

DISEASES OF LIMES AND OTHER CITRUS TREES.

MAL-DI-GOMMA.

Barbados.—No instances are recorded during 1909, but it is known to have occurred in past years.

Antigua.—One instance of what was taken to be this disease was observed at Scott's Hill experiment station.

This disease is of little practical importance in the West Indies.

MELANOSE.

Montserrat.—This was generally found on fields where the foliage had a yellowish, unhealthy tint. It was very rarely found on trees that had been covered with Bengal beans. It is not regarded as a serious pest.

Antigua.—A few isolated cases of what was taken to be this disease were observed.

This disease, like mal-di-gomma, is of very little importance, up to the present, in these islands.

FUNGOID ROOT DISEASE.

St. Lucia.—This was observed on one or two trees in three different localities. Mr. Moore remarks: 'Cutting away the diseased area and tarring the wound, together with liming the soil, appear to have checked the disease on one tree; but the removal of the tree and replanting would probably give more satisfactory results.'

Dominica.—It was more or less prevalent on many estates in the interior.

Montserrat.—Direct observations showed that this was present on three estates, but there is little doubt that it is wide-spread. The amount of damage caused by it is difficult to estimate.

Antigua.—It was noticed on two estates.

By way of explanation, it may be stated that this disease has only been observed recently, and is still under investigation. The form it takes differs somewhat in the different islands, and it seems probable that the causative fungus in Dominica is not the same throughout the different estates, and that the disease in Montserrat is due to a species different from any of those occurring in Dominica. In this last island, the attacks are mainly confined to estates in the interior where the rainfall is heavy, more especially to those which have been cleared recently; and it has been definitely shown in one or two cases that the causative fungus originated on decaying stumps and then spread to the lime trees. These it killed by destroying the bark round the collar. Usually, only isolated trees are killed in this way. If these are removed and destroyed, and the soil is limed and allowed to remain fallow for some time, it is usually found on replanting that there is no further attack. In Montserrat, the disease takes on a different form and should be kept under careful observation: it is probably wide-spread. There are indications that some relation exists between the presence of root disease and the attacks of scale insects. This point still requires considerable investigation. The identity of most of the fungi that are likely to be the primary cause of the disease is uncertain so far, as no fructifications have been found in connexion with any of them. See *Agricultural News*, Vol. IX., p. 366.

BLACK BLIGHT.

Dominica.—This occurred on limes on two or three estates which had been previously neglected. As a result of thorough cultivation and attention, the trees are improving and the black blight is disappearing. No observations on this disease are given for the other islands as the above information was inserted as a note in the Dominica report only, the disease not being one of those in the list. The observations, however, are of some interest. Extensive experiments are at present being conducted in Grenada with a view to controlling this disease. A preliminary account of them by Mr. G. G. Auchinleck, B.Sc., is published in the Minutes of the Proceedings of the Agricultural and Commercial Society, Grenada, for a meeting held on August 12, 1910.

DISEASES OF RUBBER TREES.

SUSPECTED FUNGOID DISEASES.

Grenada.—A species of Rosellinia was found on one estate attacking the stems of *Castilloa elastica*. The treatment, which consisted of excising the diseased tissues and tarring the wounds, was apparently effective.

With this exception, the various plantations both of Hevea and of Castilloa appear to be entirely free from fungoid diseases, as none have been reported from any of the islands.

DISEASE OF SWEET POTATOS.

ROOT DISEASE.

Barbados.—A few roots were observed with what seemed to be the mycelium of the sugar-cane root disease, *Marasmius sacchari*, on their surfaces.

St. Lucia.—This disease is not of importance.

Antigua.—The occurrence of a fungoid mycelium on fields of sweet potato following sugar-cane infected with Marasmius was observed on more than one occasion.

While this disease is not of much importance on account of the actual damage which it causes to sweet potatos, it is indirectly worthy of attention where these are employed as a rotation crop after sugar-canes, since, if the fungus is really the same in the two instances, root disease of sugar-cane may be carried over on the tubers of sweet potatos from one crop to the next. Although no fructifications have been found in connexion with the disease on the latter host, yet the mycelia of the fungi concerned show a remarkable resemblance to one another.

DISEASE OF YAMS.

TUBER DISEASE.

Barbados.—A few tubers at one estate were affected with what appeared to be a fungus disease, but it was not possible at the time to make any very elaborate investigations; the disease did not appear to be of very much importance.

GROUND NUT DISEASES.

ROOT DISEASE.

Grenada.—The Spanish variety of ground nut at the Botanic Station was almost entirely destroyed by this disease.

Dominica.—It was reported as occurring in the experiment plots at the Agricultural School.

St. Kitts.—The disease occurred at the Botanic Station in 1908, but was not noticed in 1909. The imported varieties, only, were attacked.

Nevis.—It was not observed in 1909, but occurred at the Botanic Station during 1908, when some American varieties, such as Dixie Giant and Spanish, were attacked.

A short account of this disease was published in the *Agricultural News*, Vol. VIII, p. 347. It appears to be common on the imported varieties of ground nut, and is undoubtedly capable of doing very serious damage. The native varieties appear to be unattacked. Experiments with a view to controlling it are at present being conducted at Dominica. A report on their results will be published later. It would seem that the cultivation of imported varieties of a superior quality will be seriously hampered until this disease is controlled.

LEAF RUST (*Uredo arachidis*, Lagh.).

St. Vincent.—This disease occurred to a considerable extent in several places.

Dominica.—It was reported as occurring on the experiment plots at the Agricultural School.

Montserrat.—The observations made were confined to the experiment plots at Grove Station. The attack was general on all the varieties cultivated. Mr. Robson remarks: 'It undoubtedly shortens the life of the ground nut and thus affects the quality and the yield.'

Antigua.—It was very prevalent.

This fungus has been known for some time as occurring on several varieties of ground nut in almost all the islands, and apparently is capable of doing some damage where the attack is severe. Local varieties are more immune than those imported, but nevertheless are not entirely free from the disease.

LEAF SPOT (*Cercospora personata*, Ellis).

Dominica.—It was reported as occurring on the experiment plots at the Agricultural School.

This disease has not been definitely reported from any of the other islands. It appears to be mainly due to excessive moisture.

A disease was also recorded as attacking this host in Barbados; the part affected was the leaf. It was not the same as either of the leaf diseases recorded above, though the cause was not definitely ascertained. In Dominica, Mr. Jones was of the opinion that all the diseases occurring in that island upon these plants were due to excessive rainfall. Together they brought about the destruction of practically the whole crop. The remedial measures undertaken were only a partial success. As was indicated above, experiments for the control of all these diseases are now in progress at the Agricultural School, and the results will be published later.

ONION DISEASE.

BACTERIAL ROT.

Montserrat.—This was found to occur on the experiment plots at the Botanic Station.

Antigua.—It was of not infrequent occurrence.

An account of this disease is given in the *West Indian Bulletin*, Vol. V, p. 134. It would appear that in some seasons it may cause considerable damage to the onion crop, where this is of any important extent.

DISEASE OF IMPHEE.

ROOT DISEASE (probably *Marasmius* sp.).

No instances of this were recorded in 1909.

DISEASE OF GUINEA CORN.

ROOT DISEASE (probably *Marasmius* sp.).

Barbados.—Instances of this occurred during the year.

The only importance of this disease, and also of the root disease of imphee, lies in the fact that the causative fungus may possibly be the same as that producing root disease of the sugar-cane. This point, however, has not yet been definitely ascertained, though it is suggested by the appearance of the mycelium on the different hosts. Should this be conclusively proved to be the case, neither of the above grasses can safely be used as a rotation crop after sugar-cane.

DISEASE OF INDIAN CORN.

ROOT DISEASE.

Antigua.—This was very prevalent. During the early part of the year it was confined to the northern and windward sides of the island, but it now appears to have spread throughout.

St. Kitts.—This was serious in some localities, particularly in the Sandy Point district, but in other places good corn was grown. No remedial measures have so far been adopted, with the exception of that comprised in attempts to secure the best seed for planting.

The actual cause of this disease is at present somewhat uncertain. Several fungi have been found in connexion with diseased plants. Of these there are two which may be responsible for the damage. The first is one which has so far been found to possess a Fusarium and a Cephalosporium type of fructification. The second is a sterile mycelium closely resembling that of a species of Marasmius, and possibly identical with the root disease fungus of the sugar-cane. This latter fungus appears to be mainly confined to portions of dead corn leaves and decaying remains of other vegetable matter caught up among the roots of the corn: nevertheless it is conceivable that it might spread from these to the living root tips. The matter is at present under investigation, as it is undoubtedly of a serious nature and may prove somewhat difficult to cope with.

GENERAL REMARKS.

St. Vincent.—In addition to the diseases already recorded as occurring in this island, a pod disease of cacao, possibly due to *Colletotrichum* sp., was reported from two estates and specimens were forwarded to the Head Office for examination.

The weather during June, July, August, September and October was wet, 10 inches of rain or more being recorded in each month at the Botanic Station.

Grenada.—In addition to attacks of thread blight as already recorded, nutmegs were observed to exhibit isolated cases of stem canker and root fungus.

Dominica.—The Coffee disease due to *Sphaerostilbe flavida*, Massee, was reported to occur on leaves, shoots and berries on one estate in the interior. (See *Agricultural News*, Vol. VIII, pp. 395 and 411.) Mr. J. Jones is of the opinion that the comparatively large number of cases of root diseases, particularly of cacao and limes, that were recorded during 1909, is no doubt largely due to the heavy rainfall that occurred on most estates, coupled with the fact that on newly formed estates, insufficient attention has been given to the question of deep drainage.

Antigua.—Mr. Tempany makes the following additions to the report from this island: 'A disease not mentioned above, which has been rather markedly present, is the leaf spot disease of sugar-cane, *Leptosphaeria sacchari*, Breda de Haan. Maize smut has also been met with sporadically. The year has been most remarkable, as far as my own observations go, for the spread of root disease of maize, the prevalence of root disease of cane and the recognition of root disease of lime trees.'

This is the first occasion upon which an attempt has been made to summarize the position with regard to plant diseases in the various West Indian islands for any one year. It is hoped to continue these reports in future years, in order that some record may be obtained of the relative prevalence or absence of the different diseases from year to year. Under normal conditions, such records would afford some test of the effectiveness of the remedial measures recommended in each instance, and would probably also afford some indication of the extent to which these are generally employed.

PART II. INSECT PESTS.

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The information contained in the following pages has been obtained in exactly the same manner as that presented in the first part of this article.

SUGAR-CANE PESTS.

MOTH BORER (*Diatreae saccharalis*, Fabr.).

Barbados.—This was not more prevalent than usual, and appeared to be kept in check by the parasitic *Trichogramma pretiosa*, Riley. Occasionally the fungus *Cordyceps Barberi*, Massee, has been found attacking the larvae, but only one instance was brought to notice during 1909.

St. Vincent.—It was fairly prevalent.

Antigua.—No very serious attack was observed, though the disease was prevalent to a greater or less extent everywhere.

St. Kitts.—It was not prevalent to any alarming extent, but was observed chiefly in the newly introduced seedlings from Antigua and Demerara.

Nevis.—It was observed during the year 1909, but no noticeable injury was inflcted on the cane crop in any part of the island.

Virgin Islands.—It was prevalent in the Bourbon cane and present to a less extent in seedling canes at the Botanic Station, but was not noticed to the same extent in the Blue Ribbon variety.

On the whole, it occurred in about the usual numbers in all the islands. The susceptibility of the newly introduced seedlings in St. Kitts is worthy of attention.

WEEVIL BORER (*Sphenophorus sericeus*, Oliv.).

Barbados.—There were not more of these present during the year 1909 than usual.

St. Kitts.—It was only met with in a very few instances and cannot be regarded as prevalent.

The insect is not reported as occurring in any of the other islands, and does not appear to have been of much importance.

ROOT BORER (*Diaprepes abbreviatus*, L.).

Barbados.—It was prevalent at the close of 1909 in some of the drier districts, especially in the south-eastern portion; it also occurred in other localities throughout the island.

St. Kitts.—This insect was observed in a few stools of canes growing in dry exposed positions along the side of the public road. It cannot, however, be regarded as prevalent.

The insect is not reported from any of the other islands, and is only of a serious nature in Barbados. There, however, its attacks may cause considerable damage, and it should be most carefully watched.

CANE FLY (*Delphax saccharivora*, Westw.).

No observations are recorded with regard to this insect in any of the islands during the year 1909.

WHITE ANT.

St. Kitts.—Sugar-cane was badly attacked on one estate in this island by termites during several years. These insects ate out all the interior of the cane stems and entirely destroyed the crop over a considerable area. About 100 acres were planted with cotton for two or three years and have now been replanted with canes. These have made vigorous growth and show no signs of attack, which indicates that the remedy has proved effective.

COTTON PESTS.

COTTON WORM (*Alabama argillacea*, Hübn.).

Barbados.—There were very few of these insects present during the year under review.

St. Vincent.--It was seen in a few fields in small numbers. No outbreak occurred in any district and no insecticides were necessary for its control.

St. Lucia.--It was present in most cotton areas though little damage was inflicted on peasants' cotton, and remedial measures were but little used. A bad attack was reported from one estate.

Montserrat.—The attacks of the cotton worm were milder than in previous years, particularly in some districts. It is claimed that the dark-coloured variety of worm is more destructive than the green.

Antigua.—No very serious attacks were reported during the year.

St. Kitts.—The attacks of this insect were less severe than in any previous year, only occurring seriously in one or two districts. Experience in the use of insecticides has enabled the planter to keep this pest under control, and the danger arising from it is far less than it was a few years ago.

Nevis.—It was not very prevalent during 1909, though it caused considerable damage in 1906, 1907 and 1908.

Virgin Islands.—It was not present in the growing season, and there were no complaints of any damage having occurred from this cause.

On the whole, this insect was much less abundant during the year 1909 than in any year since it first appeared as a pest.

BOLL WORM (*Heliothis armiger*, Hübn.).

Barbados.—There were only a few observed in 1909.

This insect is not reported from any of the other islands, and does not appear to have been of any importance during the year.

COTTON STAINERS (*Dysdercus* spp.).

St. Vincent.—It was very prevalent in certain districts towards the end of the season but the extent of the damage occasioned was not ascertained.

Grenada.—This insect was rarely found.

St. Lucia. It was present generally on cotton, but did not inflict any damage or necessitate the employment of special methods of control.

Montserrat.—It was probably more prevalent than in previous years. The insects were present in large numbers on a plot of peasants' cotton examined during the first picking. They were present almost everywhere from February 1910, onwards.

Antigua.—They were of not infrequent occurrence.

St. Kitts.—This pest was only observed when the cotton was maturing, and could hardly be regarded as sufficiently serious to necessitate the employment of remedial measures.

Nevis.—These insects attack cotton regularly, but are always more troublesome from about the middle to the end of the picking season.

Virgin Islands.—They were plentiful in certain districts, generally in low-lying situations near the sea. A good deal of cotton was damaged by this pest.

These insects have not been reported in Barbados during the past seven seasons, though they appear to be increasing somewhat in numbers in certain of the other islands. The extent of the damage for which they are responsible has not definitely been ascertained. It is interesting to note that in Montserrat, *Dysdercus delauneyi*, Leth., has greatly increased in numbers of recent years, whereas *Dysdercus andreae*, Linn., was formerly the commoner species.

SCALE INSECTS.

Barbados.—Some specimens of the black scale insect (*Saissetia nigra*, Nietn),* were observed, but in most instances these were being kept in check by the hymenopterous parasite *Zalophothrix mirum*, Craw. The white scale (*Hemichionaspis minor*, Mask.),† was also present to a certain extent but did not appear to be causing any appreciable damage.

St. Vincent.—The black scale (*Saissetia nigra*) was prevalent in the leeward district and did a considerable amount of damage on certain estates. It was not effectively kept in check by its parasites.

Antigua.—No instances were observed in which scale insects figured as a serious pest. Both the species already mentioned were seen in various localities but only on old cotton.

Nevis.—There were no attacks noted during 1909, though the insects were found on a few trees on two estates during 1907.

Virgin Islands.—Scale insects occurred chiefly on native cotton.

None of these insects are recorded from any of the other islands. It is interesting to note that while the parasite effectually controls the spread of *Saissetia nigra*, in Barbados, it is not as effective in St. Vincent.

FLOWER-BUD MAGGOT (*Contarinia gossypii*, Felt.).

Montserrat.—It was said to have been present in one instance late in the season.

Antigua.—It was not present on volcanic soils in 1909, but was fairly prevalent on limestone lands. When cotton was planted early fairly good crops were obtained, as by this means most of the damage caused by the insect was avoided.

The insect is not known to occur in any of the other islands of the Leeward or Windward groups.

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* *Saissetia nigra*, (Nietn.) = *Lecanium nigrum*, Nietn.

† *Hemichionaspis minor*, (Mask) *Chionaspis minor*, Mask.

LEAF-BLISTER MITE (*Eriophyes gossypii*, Banks.).

St. Vincent.—This pest was prevalent towards the end of the season and no second pickings were obtained in any district.

St. Lucia.- The insect was fairly common, principally because the old cotton plants were not removed in all cases.

Montserrat.—It was generally less prevalent than in previous years, though quite common at the close of the season. Such early attacks as were noted could be traced to the presence of old cotton plants bearing the pest, in the vicinity of the younger plants.

Antigua.--This was not a serious pest though it has been of common occurrence on old cotton. The remedial measures necessary, appear to be well understood.

St. Kitts.—This pest was less prevalent than in any previous year, and in nearly every instance the attack was confined to cotton that had almost finished bearing. The practice of destroying the plants at the end of the first bearing has had a great deal to do with the decrease of this pest, which in the early years was a great source of danger to the cotton planter.

Nevis.--This is always present to some extent where cotton is grown, but the attacks during 1909 were very mild compared with those of previous years.

Virgin Islands -The pest was almost universal. It is aggravated by the habit of leaving old cotton standing in the fields.

This pest has never been known to occur in Barbados: in the majority of the other islands it was much less prevalent than in previous years. Where ordinary precautions are taken it rarely appears until late in the season, when growth is not rapid and the plants have nearly finished bearing. It seems possible that its diminution in 1909 may be due in part to the gradual readjustment of the balance of nature, which was disturbed by the introduction of the cotton plant. It is also no doubt due in large part to the general employment of control measures.

RED MAGGOT *Porricondyla gossypii*, Coquillett).

Barbados.—This was present to some extent, and the local Superintendent of Agriculture suggests that it is always associated with the attacks of black arm.

This insect is known as a pest only in Barbados and was not recorded from any other island during 1909. It has been known to occur in Montserrat in past years.

COTTON APHIS (*Aphis gossypii*, Glover).

Barbados.—Only a few were present in 1909.

Although this insect is only reported from Barbados, it probably occurs in all the other islands of the West Indies, though not present in sufficiently large numbers to attract attention.

CACAO PESTS.

THRIPS (*Physopus rubrocincta*, Giard.).

St. Vincent.—These are reported as having been responsible for a considerable amount of damage on several estates, especially when the conditions of growth are unfavourable; the soil being poor, or the shade insufficient.

Grenada.—There have been slight outbreaks of these insects on cacao leaves and pods, but no treatment has been given. The dampness of the year may have kept them in check.

St. Lucia.—They were of general prevalence, but were most frequently observed in the spring months and again in August and September. They are apparently of more importance on cacao growing in bottom lands.

Virgin Islands.—Some of these insects occurred on cacao growing at the Botanic Station.

CACAO BEETLE (*Steirastoma depressum*, L.).

Grenada.—This insect occurred in about the usual numbers throughout the island. Precautions are matters of routine on many estates and appear to be reasonably effective.

It was not reported from any of the other islands.

SCALE INSECTS AND MEALY-BUGS.

St. Vincent.—Mealy-bugs were seen in most fields, but the extent of the damage caused by them is not known.

Grenada.- Both these classes of insect appear to be increasing slowly, especially on peasants' properties. The attack of Akee fringed scale (*Asterolecanium pustulans*, Ckll.), which occurred in 1908 does not appear to have spread. The species of mealy-bug appears in most cases to be *Ceroputo barberi*, Ckll.*

Nevis.—Mealy-bugs were observed but only in small numbers.

Virgin Islands.— Mealy-bugs occurred on the cacao at the Botanic Station. They were fostered by ants.

PESTS OF LIMES AND OTHER CITRUS TREES.

SCALE INSECTS.

Barbados.—The principal species occurring in this island were the purple scale (*Lepidosaphes beckii*, Newm.),* the white scale (*Chionaspis citri*, Comst.), and the green scale (*Coccus* sp.) probably *viridis*, (Green.)†. A species of *Ceroplastes*, probably *C. floridensis*, Comst., and a *Selenaspidus*, probably *S. articulatus*, (Morg.)‡ were also observed. The purple and white scales appeared to be parasitised by insects, and the red-headed fungus (*Sphaerostilbe coccophila*, Tul.) was also recorded as attacking the white scale.

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* *Ceroputo barberi*, (Ckll.) = *Dactylopius barberi*, Ckll.

* *Lepidosaphes beckii*, (Newm.) = *Mytilaspis citricola*, (Pack.).

† *Coccus viridis*, (Green.) = *Lecanium viride*, Green.

‡ *Selenaspidus articulatus*, (Morg.) = *Aspidiotus articulatus*, Morg.

St. Vincent.—The attack of these insects was reported to be universally severe. The red-headed fungus and the black fungus (*Myriangium Duriaei*, Mont.) were also recorded as attacking the purple, green, and white scales, but these natural enemies did not appear to be sufficiently vigorous to keep the pests in check. In addition to the insects mentioned above, the black line scale (*Ischnaspis longirostris*, (Sign.))* was also seen on citrus plants in this island.

Grenada.— Individual trees were attacked by purple, white, and green scales.

St. Lucia.—The purple, white and green scales were present on a few trees in most lime plantations. The same insects together with the red scale (probably *Selenaspidus articulatus*) have been present on orange trees at Union.

Dominica.—They are reported to be abundant on lime plantations which are not well cared for, while plantations which are maintained under good cultivation are practically free from their attacks.

Montserrat.—Scale insect attacks were severe in certain localities. The green scale was most abundant, decreasing in severity of attack towards the end of the year. The snow scale was especially abundant only in the southern part of the island, and the purple scale was generally distributed, but was not particularly severe in its attacks. In addition, the Lantana bug (*Orthezia insignis*, Dougl.) has been recorded as occurring in small areas.

Antigua.—These were reported as having been prevalent during the year. The snow scale and a species of Orthezia were most abundant. Purple scale was seen in small quantities, but the green scale was not noticed.

St. Kitts.—The young limes planted out were all attacked by scale insects of various kinds, and in a few instances resort was made to spraying.

Nevis.—Limes were attacked by scale insects, but the attacks were not severe.

Virgin Islands.—These occur on limes in the experiment station, while the trees in the country were fairly free.

BORER (*Leptostylus praemorsus*, Fabr.).

Dominica.—They were reported in one instance only, and in this case their presence was associated with careless pruning.

Montserrat.—They were plentiful in dead branches or dead sections of trees on one estate, and were especially common on trees that had been covered with Bengal beans.

***Ischnaspis longirostris*, (Sign,) = *Ischnaspis filiformis*, Dougl.

PESTS OF RUBBER TREES.

SCALE INSECTS.

St. Vincent.—Both Castilloa and Kickxia were badly attacked by scale insects, the species reported being *Asterolecanium pustulans*, Ckll., and *Coccus viridis*, (Green.), together with a species of white fly.

Grenada.—Castilloa was attacked by mealy-bug.

St. Lucia.—Castilloa at Union was attacked by the Akee fringed scale (*Asterolecanium pustulans*, Ckll.), which was, however, freely parasitised by the red-headed fungus.

Dominica.—Castilloa was reported as being attacked by white scale and mealy-bugs.

Antigua.—Castilloa was attacked by the Akee fringed, and other scales.

St. Kitts.—Castilloa was attacked by mealy-bugs and scale insects.

Virgin Islands.—Some scale insects occurred on the trees at the Botanic Station.

PESTS OF SWEET POTATO.

WEEVIL (*Cryptorhynchus batatae*, Waterhouse).

Barbados.—The crops in the drier districts of the island were badly attacked.

St. Vincent.—It occurred generally throughout the island,

Antigua.—More or less severe attacks were of common occurrence.

St. Kitts.—One mild attack was reported in this island.

Nevis.—It was occasionally to be found in fields where two crops have been grown in succession, but no appreciable damage was done.

This insect, which is popularly known as Jacobs or Scarabee, is a serious pest in Barbados, and also occurs as a pest in St. Vincent and Antigua. It is not of much importance in any of the other islands.

Other potato pests such as caterpillar, thrips and red spider have either not been observed during the year in any of the islands, or they have occurred in such small numbers that they have not been regarded as doing any damage. The caterpillar is reported from St. Vincent and Antigua and the red spider from Grenada and Antigua. Slugs were mentioned as being troublesome on some sweet potato plots at Union, St. Lucia.

GREEN DRESSINGS.

LEAF-EATING CATERPILLARS.

Barbados.—Woolly pyrol (*Phaseolus mungo, L.*) and Bengal beans (*Mucuna pruriens*, var.), which are the crops principally grown for green dressings, were badly attacked during the year by the larvae of more than one moth. One of these was the woolly pyrol moth (*Thermesia gemmatalis*, Hübn.); the others are not as yet determined.

St. Vincent.—These were fairly numerous on ground nuts in one district, and woolly pyrol was badly attacked, at the Agricultural School.

Montserrat.—Fields of Bengal beans were in some cases badly attacked by a green caterpillar, probably the woolly pyrol moth, and in a few cases entirely destroyed. The attack was not general and did not cause any alarm. With the extended use of the beans it may in future do damage.

Antigua.—Attacks of caterpillars were not so severe in 1909 as on some former occasions.

St. Kitts.—Pigeon peas (*Cajanus indicus*, Spreng.) and Bengal beans were attacked. No remedial measures were employed beyond turning the dressing into the soil.

In the remaining islands no attacks of leaf-eating caterpillars are recorded on crops grown for green dressings.

PESTS OF GROUND NUTS.

MEALY-BUGS.

Grenada.—The experimental plots were badly attacked. This, with the exception of an attack of caterpillars on ground nut leaves in St. Vincent, as recorded above, constituted the only example of insect pests on these plants during the year 1909.

PESTS OF ONIONS.

CATERPILLARS.

Montserrat.—There was a persistent attack in some places which was kept in check by picking.

Antigua.—The attacks were not so severe as on some former occasions.

THRIPS (*Thrips tabaci*, Lind.).

Montserrat.—There was a slight attack in one instance, not resulting in any damage.

These constitute the only insect attacks on onions recorded in the West Indies for the year under review.

GENERAL REMARKS.

St. Vincent.—The brown shield scale (*Saissetia hemisphaerica*, (Targ.))* was observed to be attacking the Madura shade tree (*Gliricidia maculata*, H.B. & K.).

Grenada.—Recurrent attacks of the potato bug† occurred on young crops of Indian corn. An unidentified caterpillar was found in one parish on Indian corn leaves, but was apparently destroyed by heavy rains.

**Saissetia hemisphaerica*, (Targ.) = *Lecanium hemisphaericum*, Targ.

†The potato bug of Grenada is probably a species of the genus *Spartocera*.—H.A.B.

St. Lucia.—The cut worm is reported to have attacked young cotton in several parts of the island, sometimes before the seedlings appeared above the soil.

Considerable damage was caused to sugar-cane on one estate by rats.

Dominica.—About 50 per cent. of the oranges at the Botanic Station were attacked by what was apparently a fruit fly. The same or another species also attacked mango and guava fruits.

Montserrat.—Indian corn was attacked by the corn ear worm (*Heliothis armiger*, Hübn.). This appears to be a pest of increasing importance in that island.

Antigua.—Attacks of corn ear worm were recorded but were not of serious importance.

St. Kitts.—Fields of young sugar-canes are often attacked to a serious extent by grasshoppers, which in some districts, and in dry seasons, cause a considerable amount of damage. Flocks of guinea birds were kept on some estates where this pest occurred, and were found most useful in controlling it.

As in the case of the report on fungus diseases, this is the first occasion upon which information of this nature has been collected. It is intended to repeat these reports in subsequent years in order to obtain some records of the increase or decrease of any given pest, and thus to determine the effectiveness of the preventive measures generally employed for its control

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[*] There is reason to believe that one or two allied species in addition to *M. sacchari* may be partly responsible for this disease.

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AN ACCOUNT OF THE REPORT OF THE ROYAL COMMISSION ON TRADE RELATIONS BETWEEN CANADA AND THE WEST INDIES.

The following account of the Report of the Royal Commission (1909-10) on Trade Relations between Canada and the West Indies is given here with the object of affording a short summary of the conclusions reached by the Commission, as well as for the purpose of making a simple record of those conclusions. The facts which are employed in the article have been supplied from the report of that Commission issued in September 1910, the largest amount of attention having been given to Part I [Cd. 5369.] The other parts, namely, Parts, II, III and IV, dealing respectively with Minutes of Evidence taken in Canada, Minutes of Evidence taken in the West Indies, and Minutes of Evidence taken in London, are printed separately as [Cd. 4991], January 1910; [Cd. 5370], September 1910; and [Cd. 5370], September 1910.

EVENTS LEADING TO THE APPOINTMENT OF THE COMMISSION.

The first of these mentioned in the report was the visit in 1890, of Mr. Foster, then Minister of Finance in the Dominion, to the West Indies with the object of considering proposals for commercial reciprocity between Canada and these colonies. The desire in the West Indies to obtain favourable terms from the United States under the McKinley Tariff Act, and other matters prevented any success in regard to the purposes for which the visit was made. The attitude of mind toward the question, on the part of West Indian producers, was still the same in 1897, as is shown by the evidence taken before the Royal Commission of that year. The change of opinion in the matter seems to date from 1898, when the Canadian Preferential Tariff was extended to the British West Indies, on the grounds that these colonies afforded large opportunities for the development of trade with Canada, and that such a policy would afford Canada a means of fulfilling some of her Imperial responsibilities. The preference consisted in a reduction of 25 per cent. on the import duties, in regard to the produce of the West Indian colonies, and in permission for British-grown sugar to enter that country at British preferential tariff rates.

The granting of this preference was not a success at first, because, as Mr. Fielding explained in his Budget speech, 1899 (in the words of the report): 'The effect of the countervailing duties imposed in the United States against bounty-fed beet sugar was to render the market of the United States more favourable than that of Canada to West Indian cane sugar.' (Part I, par. 16.) The attitude of the West India Committee, which had all along been against endangering the United States market for West Indian sugar, by any tariff arrangements with Canada, was still maintained.

Another abortive proposal was one emanating from Trinidad, in 1900, when delegates were sent by this colony to Ottawa, with the result that the Canadian Government made a proposal to the Government of Trinidad in relation to a reciprocal arrangement. Mr. Fielding's Budget speech of that year showed that the proposal included (1) free trading in the products of Trinidad and the Dominion, except in regard to spirituous liquors and tobacco, with the provision that the goods should be carried direct between the West Indies and Canada; (2) that while the duties on certain special articles imported from other countries were not to be reduced below a certain minimum, both Governments were to be left free to enter into commercial arrangements with any other part of the Empire.

It was in this year that the preferential reduction of 25 per cent. on British imports into Canada was raised to 33⅓ per cent. It was not until 1903, however, that this had much effect on West Indian trade with Canada. Certain events of that time operated in the direction of largely increasing the bulk of the sugar exports to the Dominion. These were: (1) the Brussels Convention of 1903, which, aiming at the abolition of bounties, caused the disappearance of the American countervailing duties of bounty-fed sugar, and made the American market less attractive to the West Indian producer; (2) the surtax that was imposed in that year on imports from Germany into Canada, which has had the effect of reducing the imports of German sugar into the Dominion almost to nothing; (3) the United States preference to sugar imported from Porto Rico, the Philippines and Cuba—a circumstance which has increased in effect since Porto Rican sugar has been admitted free into the United States, and since that from the Philippines and Cuba has been enabled to enter on special terms; (4) the increase in the consumption of sugar in Canada, which has been from 104,000 tons in 1899 to 185,000 tons in 1909. The effect of these various causes is shown in the fact that, while the exports of sugar from the West Indies into the Dominion did not increase much above 11,000 tons, up to 1903, they reached 133,000 tons, in 1909.

It was owing to this importance that the Canadian sugar market had gained, in relation to the West Indies, that proposals were renewed for a reciprocal arrangement between the two countries. In pursuance of this, suggestions for a reduction of 10 per cent. on goods from Canada were brought before the Government of British Guiana; these were declined. In the following year, the proposals of 1900 were revived by the Trinidad Chamber of Commerce, without effect.

The next step in the matter was the sending of a Commission of three delegates from the Boards of Trade of Toronto, Halifax and St. John, to the West Indies, to study the trade conditions. The scope of the matter was extended, in the same year, with the result that a conference on the trade relations between Canada and the West Indies was held in January 1908, in Barbados. This conference was attended by delegates from the West Indies and from the Dominion Government, and its policy was the exchange of views rather than the acceptance of binding resolutions of any nature whatever. It concluded by adopting resolutions in favour of: (1) negotations for reciprocal tariff concessions; (2) the establishment of cheaper telegraphic communication between Canada and the West Indies; and (3) of the provision of improved transportation facilities in connexion with trade between the West Indies and Canada.

This conference was followed by attempts, on the part of the Governments of Barbados and Antigua, to make tariff arrangements in those colonies which would be favourable to Canada. It was seen, however, by the Canadian Government, that the making of independent reciprocal arrangements with the separate colonies would be a matter of difficulty, if not impossibility. A report dealing with the circumstances was, therefore, submitted to the Committee of the Privy Council of Canada by the Minister of Finance. The report of this Committee, made after the consideration of the first-mentioned one, pointed out that while the action of Barbados indicated a substantial and gratifying advance towards reciprocity between the West Indies and Canada, there were the following objections to the immediate conclusion of a reciprocity agreement: (1) that apart from the further concessions demanded of Canada, the list of articles of British origin upon which a preference would be granted in Barbados omits some items of Canadian export upon which favourable tariff treatment is very desirable; (2) the fact that the making of such an arrangement by Canada with one Colony only presents difficulties that might not arise in the case of a more comprehensive scheme. (Part I, p. ii.) In the end, the suggestion was made that a conference should be organized by Imperial authority in the form of a Royal Commission, or in some other expedient manner. It was this suggestion which resulted in the appointment of the Royal Commission whose report forms the subject of this article. In concluding this section of the report, brief reference is made to some recent changes in Canadian legislation as regards the importation of sugar. These are as follows: (1) in April 1907, the flat reduction of one-third from the ordinary tariff rates was substituted by special rates, with the provision of intermediate tariff rates between the general tariff rates and the British preferential tariff; (2) since this, intermediate rates on a number of articles have been granted to several countries, without affecting that with regard to sugar; (3) in 1907, the Canadian Government granted the beet sugar factories in that country the privilege of importing foreign raw sugar, under the British preferential tariff rates, up to 2 tons for every ton of refined sugar produced from Canadian beet, till 1909, with a reduced scale for the next two years; (4) the 1907 Budget granted the Canadian refiners: 'the privilege of importing foreign sugar at the British preferential rate to the extent of one-fifth of the refined sugar which they produced;' importations of molasses into Canada, direct from a British possession have been free of duty, since 1904. (Part I, par. 24.)

The constitution of the Commission, appointed under the circumstances related in the last paragraph, was as follows:—

The Right Honourable Lord Balfour of Burleigh, P.C., K.T.

The Honourable William Stevens Fielding, The Honourable William Paterson, Sir John Poynder Dickson-Poynder, Bart., D.S.O., M.P.,* and Sir Daniel Morris, K.C.M.G., together with Hubert Russell Cowell, Esq., B.A., Secretary.

CHANGES IN WEST INDIAN CONDITIONS SINCE THE ROYAL COMMISSION OF 1897.

These are best indicated by means of a table which is given in Part I of the Report of the Commission, and is presented here as follows:—

Colony, etc.	Total Exports of Produce and Manufactures of Colony. 1896.	Total Exports of Produce and Manufactures of Colony, 1908-9.*	Exports of the Products of the Sugar-cane (Sugar, Rum and Molasses), 1896.	Exports of the Products of the Sugar-cane (Sugar, Rum and Molasses), 1908-9.	Percentage in 1896.	Percentage to Total, 1908-9.
	£	£	£	£		
Jamaica	1,700,000	2,085,700	300,000	263,850	18·0	12·6
British Guiana (excluding gold)...	1,353,000	1,688,270	1,280,000	1,474,060	94·5	86·0
Trinidad	1,363,000†	1,902,880	773,000†	469,900	57·0	24·7
Barbados	577,000	608,000	558,000	506,390	97·0	83·2
Grenada	182,000	288,300	—	Trifling	—	—
St. Lucia (excluding coal)...	85,000	120,300	63,000	64,190	74·0	53·0
St. Vincent	57,000	88,700	24,000	6,127	42·0	6·9
Antigua	127,000	117,840	119,000	104,470	94·5	88·6
St. Kitts-Nevis	109,000	148,070	105,000	117,990	96·5	79·0
Dominica	48,000	102,000	7,000	Nil.	15·0	—
Montserrat	24,000	45,300	15,000	683	62·0	1·0

* Latest figures available. † Excluding Tobago.

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* Raised to the peerage with the title of Lord Islington, on his appointment to the Governorship of New Zealand before the Report was submitted.

This is followed by a table given for the purpose of illustrating the diversion of West Indian trade from the United States since 1899. It presents the value of the sugar exported from British Guiana—the largest sugar-producing colony—to the United States and Canada, in recent years:—

Year.	To United States.	To Canada.
	£	£
1899-1900	782,500	3,860
1901-2	800,400	73,690
1903-4	403,896	601,400
1905-6	296,730	647,540
1907-8	Nil.	858,800
1908-9	268,960	756,306

THE CONDITIONS IN THE SEVERAL COLONIES.

It is not necessary, in an article of this kind, to go into details in regard to this matter. It will be sufficient to give figures, taken from Part I, pars. 33-40, of the report, showing the changes in trade that have taken place since the period 1896-7. These are summarized in the following table:—

Colony.	1896-7.	1908-9.	Increase.	Per cent.
	£	£	£	
Jamaica.				
Revenue	751,987	933,751	179,664	24·0
Imports	1,856,378	2,420,335	563,957	30·0
Exports	1,470,241	2,268,254	798,013	54·0
British Guiana.				
Revenue	567,719	540,054*	27,695	– 5·0
Imports	1,443,553	1,784,574	341,021	23·0
Exports	1,353,000	1,832 859	479,859	36·0
Trinidad and Tobago.				
Revenue	611,534	834,745	223,311	36·5
Imports	2,161,231	2,682,702	521,571	24·0
Exports	1,991,926	2,500,195	515,269	26·0
Barbados.				
Revenue	185,532	189,805	4,273	2·3
Imports	1,048,866	1,225,869	176,983	16·7
Exports	758,227	948,178	189.951	25·0
Grenada				
Revenue	56,210	73,182	16,972	30·0
Imports	175,712	303,783	128,071	70·2
Exports	172,020	359,245	187,225	109·0
St. Vincent.				
Revenue	26,487	31,395	4,908	18·5
Imports	71,490	113,713	42,223	59·0
Exports	67,392	94,739	27,347	45·8
St. Lucia.				
Revenue	55,331	65,694	10,363	18 0
Imports	190,535	289,775	89,241	46·0
Exports	126,295	152,380†	16,085	11·0
Leeward Islands.				
Revenue	121,561	154,333	33,772	27·7
Imports	340,112	546.750	206,638	64·8
Exports	351,429	517,467	166,038	47·2

* Duties reduced from 15 to 12½ per cent., in 1908-9. A reduction of 5 per cent., also in 1904.

† Excluding bunker coal.

THE VALUE OF THE CANADIAN PREFERENCE IN THE WEST INDIES.

In relation to this matter, the following conclusions may be deduced shortly from the report of the Commission: (1) that the Canadian preferential policy has been already of very great benefit to West Indian sugar producers; (2) that, taking one year with another, British West Indian sugar producers have received from a third to a half of the preference; or approximately from 9*s*. to 14*s*. per ton above the price obtainable without the preference; (3) that the Canadian preference has widened the market for West Indian sugar, as is shown by the fact that during 1907-9, Greenock refiners have paid prices for West Indian sugars which exceeded the current prices of Java sugar; (4) that: 'the Canadian preference . . . . . supplements the Brussels Convention in giving to the West Indian sugar industry that security, the want of which threatened it at one time with extinction.' (Part I, par. 49.)

This part of the report goes on to point out that the securing, by the West Indian producer, of the whole of the preference at present granted would be a matter of unfairness to the Canadian refiner, because it would cause him to have to pay a higher price for his raw sugar, without receiving compensation in relation to the competition of imported refined sugar.

With reference to the operation of the preference in regard to the different kinds of sugar produced in the West Indies, it is pointed out that the matters brought forward already apply particularly to sugars known as 'centrifugal', 'dry', or 'refining crystals', but that some modification of them is required in relation to muscovado sugar. This is because the lower sucrose content of this sugar makes it less acceptable to refiners unless it is sold cheaply, or unless there is a shortage of the other sugars. It is considered that, although for some time before 1907, the Canadian refiners gave the producers of muscovado New York prices, together with half the preference, there is a doubt, at the present time, as to if, under ordinary conditions, the producers of this sugar obtain an appreciable proportion of the preference. As far as molasses is concerned, although it has at present a large market in Canada and Newfoundland, being especially acceptable on account of its high sucrose content, it is the opinion of the Commission that this market is not necessarily permanent, some of the evidence in Canada having adduced the fact that the product is being replaced in that country by sugar in a dry form. The production of muscovado sugar is regarded by the Commission as a declining industry, and it is urged that every effort should be made to introduce improved methods of manufacture into the West Indies; the benefits conferred on Antigua by the Central Sugar Factory are brought forward in support of this suggestion. Further, the Commission considers that it is only the great natural advantages possessed by Antigua, Barbados and St. Kitts that have enabled the muscovado industry to survive.

These matters relate to the preference in so far as it benefits the sugar producer; considerations are brought forward to show that it is also of advantage to the Canadian refiner, in that: (1) a large body of producers having an interest in selling to him is created, by the existence of which he is relieved to a large extent of the necessity for meeting others in competition, for supplies in other markets; (2) the reduction of duties effected by it probably stimulates consumption, and thus enlarges the refiner's business.

Consideration of the value of New York quotations for non-preferred sugar as a basis for the calculation of prices led to the discrediting of quotations in that market as a basis for calculation throughout the year, especially as the difference between Canadian and New York prices, during the year, varies from nothing to a value greater than the total preference. The Commission is not satisfied that the necessary conditions are fulfilled by any other market, though a fairly reliable criterion is supplied in the Hamburg prices for beet. Attention is drawn to the incorrectness of the statement that anything paid to the producer above the current New York prices is the amount of the preference received by him, when New York quotations are nominal; that is to say, during the earlier parts of the year when that market is receiving Cuban sugar in large quantities. In the matter of choosing a basis to be agreed upon between buyer and seller, it is unlikely that such an agreement will be reached, because: (1) the buyers are thinking of the cheapest market in which they can make purchases, and the seller of the dearest market in which he can dispose of his sugar: (2) the comparisons must be made with the aid of terms that are precisely equivalent; and (3) the conditions of sale and the variations of trade prevent any one set of figures being taken as an invariable basis. These are the chief considerations; there are others which relate to the necessity for allowance of differences in freight and insurance, and to the fact that the Canadian refiners prefer to buy their sugar as they want it, rather than to carry stocks.

It has been alleged by both refiner and producer that co-operation was taking place on the side of the other party, of such a nature as to damage his interests. It seems that there has been actually something in the nature of co-operation on the part of producers, although the buyers have been prone to think that this has existed to a far greater extent than is actually the case. Reference is made to the serious position that is created through the permission which was given, early in 1909, to the Canadian refiners to obtain 20 per cent. of the non-preferred sugar upon the preferential terms. It is recognized that such permission enables them to exert pressure upon the West Indian producer. The matter is far-reaching, because, unless it is re-arranged in such a way as to regain the confidence of the producers, the question of reciprocity with Canada is likely to be met with many additional difficulties. In illustration, figures are given which indicate that it would be possible for the refiners to import foreign sugars at preferential rates to such an extent as to reduce the Canadian need for West Indian sugar from 198,000 tons to 120,000 tons, approximately. It is pointed out, in presenting these figures, that due consideration must be given in all such arguments to the fact that the Canadian market is rapidly expanding.

Returning to the matter of the mode of granting the preference, and the determination of its amount, it was strongly represented to the Commission that the concessions by which refiners are enabled to import a certain amount of foreign sugar under preferential rates should be withdrawn. The Commission has given careful consideration to the question of the possibility of finding a settled means for determining the proportions of the preference which should be received by the growers and refiners, respectively: no such means seems to be entirely practicable. Neither does it seem to be possible to establish a tribunal to decide between the advantages that are being received by each party, at any time. Mention is made of the suggestion by Sir Nevile Lubbock: 'provided that the concession to the refiners were withdrawn, a much smaller preference than at present exists would attract West Indian raw sugar to Canada, and would be regarded as a material benefit by the growers,' and it seems to the Commission that a solution of the difficulty may be found in some manner similar to this. (Part I, par. 71.)

THE QUESTION OF RECIPROCITY.

In relation to this, a review is given first of the circumstances surrounding the preference granted by Canada to the West Indies. It is pointed out that, while the Dominion Government demanded no concession in return, nor even enquired into the effect of the colonial tariffs on the trade of Canada, the Canadian market has become of great importance to producers in the West Indies, largely on account of this preference, even though until the time of the Brussels Convention, the effect shown from the preference was not great. The danger of the sudden withdrawal of the preference is realized, especially as the United States is prevented from becoming a market for West Indian sugar, and there are the disadvantages. as far as the markets of the United Kingdom and the Colonies are concerned, of distance under conditions of competition with Continental beet. The present mcertainty makes the position unsatisfactory: for, although Canada has given the preference gratis, it would be a perfectly ust course for it to be withdrawn if the interests of that ountry demanded such a course. The representation is there- ore made: 'if this contingency can be avoided, or even eferred, by some present concession on the part of the West ndian Colonies, that concession ought to be made. The vidence of most, if not all, of those interested in the prosper- y of these Colonies was strongly in support of this recom- endation, and the only divergencies of opinion related to the nount and manner of the concession which the individual lonies could afford, or ought to be called upon to make.' art I, par. 74.)

This leads to the question as to the nature of the considera- n to be offered to Canada by the West Indies in order that non-withdrawal of the benefits under the preference shall be assured. A review of the ways in which this may be done leads to the following conclusion: 'the grant of a reciprocal preference is the only policy which is at all likely to command any measure of approval either in the West Indian colonies or in the Dominion. While in some circumstances objection might be taken to the inauguration by a group of Crown Colonies of a system of discriminatory tariffs, we feel that the very special relations which exist between Canada and the West Indies justify us in supporting the adoption of such a policy in this case.' (Part I, par. 76.) The Commission found, in relation to this, that it was generally recognized in the West Indies that concessions made to Canada should also exist in the same way in relation to the United Kingdom, and that this view of the matter was also taken in Canada. The question as to the articles to be selected for preferential treatment receives careful consideration and, as a result of the proposals that were made in Canada and the West Indies, a list of the articles has been drawn up by the Commission, which it is suggested might be subject to preferential terms in regard to Canada. This list is given in Schedule A, Appendix I, Part I, of the Report. As regards the amount of the preference, a general agreement was found that the rates of duty levied in respect of articles coming under it should be less by 20 per cent. than those in the general tariff. The suggestions that come forward, in relation to the giving of the preference, are that this may be done by: (1) reducing duties on imports from Canada and the United Kingdom, or (2) keeping the existing duties for goods from those places, and raising the rates on goods of other origin, or (3) by combining these methods. There is thus, in relation to (3), the suggestion that the existing duties should be reduced by 10 per cent. in favour of Canada and the United Kingdom, and increased by the same amount against foreign countries. The Commission deems this worthy of consideration, where the financial circumstances of a colony would not permit of the full 20 per cent. reduction immediately, in regard to Canadian and British goods. The second proposal, namely, that existing rates should be kept for Canada and the United Kingdom and that they should be increased for other countries, would meet with opposition in many cases because of the additional taxation that this would incur, for a time at any rate. The recommendation of the Commission is to the effect that: 'an effort should be made in every Colony to create the preference by a reduction of duties, and we would hope that financial readjustments might be made which would render this possible. In particular we would suggest that careful consideration should be given to the possibility of meeting the deficit, in part at least, by an increase in the excise duty on rum. In many Colonies the system now existing results in giving the local production of rum considerable advantages, and a very slight increase in the excise duty would, in most cases, produce all the revenue required. A valid justification for such a course lies in the fact that it is the sugar industry which is most closely interested in the retention of the advantages of the Canadian preference, and which also benefits by the existing protection of rum.' The report goes on to state; 'We think that pointed out, in presenting these figures, that due consideration must be given in all such arguments to the fact that the Canadian market is rapidly expanding.

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The difficulty of the subject is increased by the differences which exist in the prosperity of the various West Indian colonies, and the consequent difference in ability to lower the rates on imported goods in favour of Canada. This is one of the reasons why uniform tariff rates for all the colonies are not possible; though the making of these would be an improvement on the present state of affairs, especially as this would tend to draw the colonies closer together. The matter of necessity seems to be the establishment of a uniform minimum amount of preference, leaving the colonies free to impose their own duties. An illustration (Part I, par. 86) is given in connexion with this, for the purpose of which it is considered that a colony might be free to impose such rates of duty on its imports, provided that the duties on goods from Canada should not be more than four-fifths of those on other goods. As regards Canada, on the other hand, the Government would decide the rates of duty for itself, but would provide that the duties on imports from the West Indies should not be more than four-fifths of those on goods from foreign countries. Another matter of difficulty is to decide what has to be done in regard to goods on the free list. The best general course would seem to be that either party should use its own discretion in the matter, interference only being made in cases that merit special treatment. In relation to the working of any scheme of preference, a form of agreement is tentatively given, in Appendix I to the Report, which is intended to form a basis for consideration and modification in the future, in the event of a decision that the West Indies shall trade reciprocally with Canada.

Certain of the colonies occupy a special position in regard to the policy of granting a preference to goods from Canada In Montserrat, the list of articles given, which could be admitted under terms favourable to that country, was short. It is suggested, however, that in view of the general feeling in the matter in the island, and its present prosperity, this list could well be extended. The circumstances of Dominca differ particularly, from those in most of the other islands, in that the trade of that island with Canada is very small at present, amounting to less than 2 per cent. of the total exports. The fact that the products of this island are sent chiefly to the United States leads to the fear of retaliation by that country in the event of any participation by Dominica in a scheme of preference with Canada. There is the additional matter of the opinion of the Planters' Association of that island, which is to the effect that any benefit which may accrue would not justify the loss of revenue that would result from the adoption of the policy. As regards these questions, however, the view is taken that it does not seem probable that retaliation would take place on the part of the United States, and it is not likely that the granting of the preference would lead to a serious loss of revenue. This view of the question seems to be further justified by the fact that the proposals for reciprocity with Canada are largely accepted, in principle, in Dominica. Loss of revenue, again, comes into consideration in the case of the Virgin Islands. It is the opinion of the Commission in this case, once more, that the extent of this loss would be too small to justify the taking of a position by this colony independent of that adopted by the other Presidencies in the Leeward Islands. The distance of Jamaica from the other colonies, and the large preponderence of its trade with the United States over that of Canada, make the circumstances of this colony very special. The connexion of its commercial interests with the United States cause it to be certain that considerable opposition exists toward any proposals to grant a preference to imports from Canada. Consideration of these matters leads the Commission to recommend, as regards Jamaica: 'that in any arrangement that may be discussed between Canada and the West Indian Colonies it should be understood that the position of Jamaica is entirely distinct from that of the other Colonies, but the way should be left open for the subsequent adhesion of Jamaica if that Colony should afterwards so desire.' (Part I, par. 116.) The instructions received by the Commission from the Secretary of State for the Colonies made the term British West Indies to include, for the purposes of the enquiry, Bermuda, the Bahamas and British Honduras, as well as British Guiana. Like Jamaica, the three first-mentioned colonies are geographically distinct from the remainder of the British West Indies. As regards Bermuda. the Commission was informed of the circumstances of the colony by a committee appointed for the purpose, most of the members of which did not think it advisable for the colony to enter into any scheme of preference in regard to Canada. The matters that were considered in arriving at this conclusion are given in the Appendix to the evidence. The Commission suggests that further consideration should be given to the question in the light of its report. The circumstances of British Honduras make reciprocity with Canada even less likely, especially as, unlike the case of Bermuda, there is no direct steamer communication with Canada. The result is that the Executive Council in the colony regards it as being, at present inadvisable to enter into a reciprocal trade arrangement with Canada.

The independence of Newfoundland with respect to Canada makes its case require special consideration. It is the desire of the Government to share in the benefits that might be granted to Canada, and willingness is expressed in the matter of assisting in the granting of a subsidy for a line of steamers from this colony and Canada to the West Indies. With reference to the first matter, the Commission is of opinion that no objection would be made by Canada to the sharing by Newfoundland of the preference. The second circumstance, however, entails more difficulty, because there is the fear that a joint service from Canada and Newfoundland to the West Indies is not practicable, on account of the geographical position of that colony. The suggestion is therefore made that the provision of a branch service from Newfoundland, linked up with the West Indian service at Halifax or St. John, would meet the case.

The fear of retaliation by the United States in the event of the granting of preferential treatment to Canada has been mentioned already, in dealing with Dominica. The opinion is expressed, however, that there does not appear to be any need for alarm on this account. 'It may now be regarded as a settled principle that trade arrangements between parts of the British Empire are to be considered matters of a domestic character, which cannot be regarded as discriminatory by any foreign power.' (Part I, par. 122.)

STEAMER SERVICE BETWEEN CANADA AND THE WEST INDIES.

In Section XII of the report, consideration is given to the conditions of the steamer service between Canada and the West Indies, since the agreement, in July 1900, between the Canadian Minister of Trade and Commerce and Messrs. Pickford & Black. The history of the matter shows that Messrs. Pickford & Black, by the 1900 agreement, received an annual subsidy of £27,000, one half being paid by the Canadian Government and one half by the British Government. Particulars of the routes to be followed are given in the report. The agreement was to last till July 1, 1905. Near the time of its termination, the Secretary of State for the Colonies approached the Dominion Government with a view to obtaining a better service. Other companies, such as the Royal Mail Steam Packet Company and Messrs. Elder, Dempster & Co, were permitted to take part in the negotiations; but the suggested conditions could only be finally accepted by Messrs. Pickford & Black, who made the following proposals for future procedure: (1) to continue the existing service, with some small improvements; (2) to run a service every twelve days from Halifax to British Guiana, calling at Bermuda, St. Kitts, Antigua, Montserrat, Dominica, St. Lucia, Barbados and Trinidad. The changes suggested in the second proposal were the outcome of the complaints by the company that a loss was caused through having to call at ports where there was little cargo to take up, such as Grenada, St. Vincent and Tobago, and that expense and loss of time were incurred in calling at St. John. The original contract was extended for another year, from 1905, in order that time might be given for the negotiations, and eventually the second proposal being thought the more advantageous to the West Indies, an agreement was concluded for the service every twelve days from St. John and Halifax, the particulars of which are given in paragraph 125 of Part I of the report. The following conditions were to be fulfilled by the company: (1) the departures from St. John to British Guiana were to take place within fourteen days of one another; (2) the steamers employed were to maintain an average speed of not less than ten knots an hour; (3) the time-table to be followed was subject to the approval of the Minister of Trade and Commerce; (4) provision was to be made for the carriage of mails; (5) the Minister was given power to fix the maximum rates for the carriage of passengers and goods to and from the West Indies; (6) an extra steamer was to be provided for use during the sugar crop, if this was required. The original subsidy was maintained, and it was provided exactly as at first; the contract was for four years. A temporary arrangement was subsequently made, to the effect that the steamers should call at Montserrat when bound south; nothing was done, however, in favour of Grenada and Tobago. The latter circumstance caused dissatisfaction, which was increased by the fact that the Canadian service could not be co-ordinated with the intercolonial service of the Royal Mail Steam Packet Company, because its period was one of twelve days, whereas that of the latter company is fortnightly; the twelve days' service was, however, supported strongly by the Halifax Board of Trade, and has been maintained up to the present.

The evidence given before the Commission has shown repeatedly that the present service has not been satisfactory. The complaints made, in both Canada and the West Indies, related to (1) the unsuitability of the steamers; (2) the inadequate accommodation, both for passengers and freight: (3) the high rates for certain classes of cargo; (4) the lack of care in transit; (5) the delay incurred by shipments from St. John, owing to the call at Halfax; (6) the uncertainty of finding space when the steamers arrived at the Northern Islands, even though accommodation may have been reserved in advance. An explanation of some of the matters of complaint is contained in a letter from Mr. W. A. Black, which is included in Appendix XVII of Part IV of the report. This has reference more especially to the line between Canada and Jamaica, and deals particularly with the following points: (1) the steamers employed were specially built for the American fruit trade, and are fitted as efficiently as most of the ships running between Jamaica and the United States; (2) with regard to passenger accommodation, this is fair; the provision of expensive accommodation would not pay, unless a reasonable number of travellers could be guaranteed; (3) that with respect to Newfoundland, the service was very good, as there are four boats each month to Halifax from St. John's and two to New York; (4) Jamaica cargo has not been shut out by Cuban cargo, because the policy has been always to accept the former, first; (5) difficulties have been caused to the contractors, because of the lateness in sending up orders for ships, in Jamaica; (6) cases have occurred where an emergency steamer has been provided in order to give assistance to shippers, although there was no obligation on the part of the company for this to be done; (7) the facilities for obtaining cargo from St. John's by way of Halifax are better than those by way of New York, because there are four boats each month to Halifax, but only two to New York; (8) the records of the company show that the service is regular and dependable; (9) an agreement has been entered into with the United Fruit Company, for the shipment of a minimum quantity of bananas by the boats of the company, with satisfactory results on both sides; (10) the exporter of cocoa-nuts from Jamaica has no grounds for complaint, as there is always room for this product; (11) alternative bills of lading have been issued to sugar shippers giving them the privilege, when the steamer lies at Halifax, of selling the sugar there, or of forwarding it to the Clyde, London or the Continent, under the same rate of freight on the through bill of lading as could be obtained by direct steamer from Jamaica; (12) in regard to the alleged shutting out of cargo by the steamers of the company, this has happened only occasionally: on the other hand, evidence is given which shows that, even when special steamers have been chartered by West Indian shippers, the latter have sometimes failed to provide the cargo to justify the the putting on of those steamers.

Several matters are adduced to show that there has been a certain amount of advantage, in the past, in shipping to New York, and the general opinion among witnesses in Canada was that, to meet the competition from that port, a weekly service of steamers from Canadian ports was desirable; it was stated further, that these steamers should maintain a speed of at least twelve knots. In the West Indies, the general opinion was that the needs of the smaller colonies could be supplied adequately by fortnightly steamers; it was in the larger colonies that a weekly service seemed to be mostly in favour.

After further discussion of the matter, the report states: 'We are of opinion that the most efficient service might be obtained by dividing the service into two parts. In the summer there should be one fortnightly sailing from Halifax, and another fortnightly sailing from Montreal, calling at Quebec and St. John. The services should be so arranged that the departures from Halifax and St. John should take place on the same day of alternate weeks, thus forming a weekly service from Canada; giving to Halifax and St John the direct connexion with the West Indies which they desire, and giving Montreal and Quebec the opportunity to send their goods to the West Indies entirely by water during the season of open navigation.

'In the winter the sailings would be from Halifax and St. John only.

'In the summer service it should be laid down that the steamers on the St. John route should start from Montreal a specified number of days before the due date of departure from St. John.

'As it is desirable that there should be no delay through the calling of the steamers for coal on the voyage, it should be stipulated that the Montreal-St. John steamers should be fully coaled at Montreal, and the Halifax steamers fully coaled at Halifax, for the outward voyage, and that if additional coal be required for the homeward voyage, the coaling arrangements should be such as would avoid delay as far as possible.' (Part I, par. 137.)

It is stated, further, that the West Indian colonies should possess a ready means of making the company adhere to its time-table, and that, in pursuit of this, in any future contract either with the Imperial Government or with any West Indian colony, 'power should be given to the Secretary of State to enforce penalties for any breach of the contract which may affect West Indian interests.' (Part I, par. 138.) Another matter to which attention is given is the necessity for the provision of rapid railway service, in Canada, in connexion with the steamers. A review of the evidence in relation to the suggestion for a trunk service shows that this is undesirable, particularly in regard to the necessity for transhipment which it incurs. The official witness in St. Vincent placed before the Commissioners a scheme for meeting the requirements of both the larger and the smaller colonies; this is given in the Appendix to Part III of the Report, to which reference is made. The principle of the scheme is that 12½-knot steamers, having a capacity of 3,500 to 4,000 tons should proceed from a Canadian port directly to the larger ports, returning by all the ports now served, together with Grenada, for one week; while for the second week, it would visit all ports, returning direct, with the exception of calls at Trinidad and Barbados.

After considering the claim of several of the islands in regard to which there has been difficulty in the past, the report presents the following matters in connexion with the provision of an efficient steamship service between the West Indies and Canada: (1) the development of the trade between the two countries is largely dependent upon the provision of adequate means of transportation, and it is specially represented: 'that the maintenance and improvement of the steamship service between Canada and the West Indies is in the highest degree essential' (Part I, par. 153); (2) the withdrawal of the present service would be exceedingly detrimental to the increasing trade that is in existence between the two countries; (3) the need for the continuance of the subsidy, and the fact that the West Indian colonies cannot provide it at present, make it necessary that this shall be supplied, under existing conditions, by the Imperial and Canadian Governments; (4) it is probable that if the Canadian market was lost to the West Indies, serious deficits would appear in the revenue of several of the colonies; (5) the West Indian market for Canadian goods is likely to become larger, if an improved service is maintained; (6) the provision of adequate steamer service would assist the effects of preference, on account of the diversion of trade to the subsidized steamers. This section of the report ends with the following statement: 'In conclusion, we venture again strongly to represent to Your Majesty that it is essential for the present to continue the payment of a subsidy for a service of steamers between Canada and the West Indies.

'While we are convinced that the subsidy required for this service must continue for the present to be provided, at any rate in part, by the Imperial Government, we do not fail to recognize the desirability of securing some contribution from those of the Colonies in the West Indies whose finances permit of such an expenditure.' (Part I, par. 160.) Subsequent events extended the question to include the consideration of a proposed mail service from the United Kingdom and Canada to the West Indies. This is on the same general lines as the scheme which has just been outlined, but 15-knot vessels are suggested in connexion with it. In relation to this, reference is made to paragraphs 161–5, of Part I of the Report. The next two paragraphs have regard to the Jamaica service, which would be entirely independent of that with the other parts of the West Indies.

THE IMPERIAL DEPARTMENT OF AGRICULTURE FOR THE WEST INDIES.

Section XIII deals with matters relating to this Department, reviewing its duties and making short reference to some of the services that have been rendered by it in the past. The conclusion is reached: 'the Department has been of enormous practical utility to the West Indian Colonies and has had a large share in the gratifying improvement in the condition of the Colonies which has recently been apparent.' After pointing out that it is probable that the finances of the several colonies will very shortly permit of their bearing the whole expense of the local Agricultural Departments, it is strongly urged that it should be decided, at an early date, that the cost of the central office—about £5,000 a year—shall be provided for a definite term of years.

GENERAL RECOMMENDATIONS FOR THE DEVELOPMENT OF TRADE BETWEEN CANADA AND THE WEST INDIES.

The next section (No. XIV) of Part I of the Report has reference to general recommendations for the development of trade between Canada and the West Indies, and the following are the main points which are elucidated: (1) the question of transportation is only subsidiary to the provision of facilities at the ports for the handling of the trade by commission houses with promptness and despatch; (2) though the former matter is one in which much reliance has to be placed on Government assistance, it is to private enterprise that one must look for the establishment of commission houses; these should be similar to those in New York, and may well be placed at Montreal, Quebec, Halifax and St. John; (3) facilities should be provided in Canada for storing goods at the actual port of shipment, in order that supplies may be obtainable at short notice; (4) a greater effort is required, on the part of Canadian manufacturers and exporters, to bring the attention of buyers in the West Indies to their goods, more especially by increasing the number of Canadian commercial travellers; (5) the business methods employed by Canadian houses have several points of inconvenience in relation to West Indian trade, showing the necessity for a better understanding of what is required in this; (6) the appointment of a Trade Commissioner, having full knowledge of the circumstances of the West Indies, who should represent these colonies in Canada, would be attended with beneficial results, and it is suggested that the cost of the appointment should be shared among the colonies and that the office could be closely associated with the Imperial Department of Agriculture.

DEVELOPMENT OF THE FRUIT TRADE WITH CANADA.

In connexion with this subject, a proposal was placed before the Commission by Dr. F. Watts, C.M.G., Imperial Commissioner of Agriculture for the West Indies. This proposal, which is published as an Appendix to Part III of the Report, is reproduced at the end of this article.

TELEGRAPHS.

The general trend of the evidence given in connexion with telegraphs was to show that: (1) charges are excessive; (2) there have been many interruptions, through injury to the cable, particularly in regard to the service for British Guiana, causing much inconvenience; (3) certain anomalies arise on account of an agreement which has existed for a long time between the Cuba Submarine Cable Company and the West India and Panama Telegraph Company. After reviewing the general conditions surrounding the matter of telegraphy in the West Indies, and giving a short history of the various companies concerned, the report proceeds to deal with proposals that have been received in the past for the improvement of facilities. Up to the present, the schemes put forward from time to time have been uniformly rejected; they have included: (1) those laid before the Inter-departmental Committee on cable communications, 1902 [Cd. 1056], which left the ultimate solution of the problem to the treatment of the West Indian cable as part of a larger system; (2) those suggested by Colonial Office Committees sitting in 1901 and in 1906-7, by whom the obtaining of tenders for wireless installations was recommended, without satisfactory results; (3) the scheme submitted by the West India Committee, in 1906, which asked for a cable direct from Bermuda to Barbados, Trinidad and British Guiana, but which was not accepted on account of the increased expense and its inadequate provision for the smaller colonies; (4) proposals which have been made during the past eight years, for wireless installations in several of the colonies: the experimental state of radio-telegraphy at the time, and the fear of interference of existing interests, did not enable these proposals to be entertained. Of the suggestions brought before the Commission, the most definite was that on the part of the Bermuda Companies, which was practically that brought forward by the West India Committee in 1906, with the addition of wireless communication for the smaller islands, Jamaica and British Honduras. Among the most complete schemes submitted was that of the Marconi Company which, though the most expensive, would probably be found lower in cost, if the figures submitted were brought up to date.

The following definite statement occurs in the report: 'It is impossible, we think, not to recognize that improved telegraphic facilities are essential to the development of trade between Canada and the West Indies, and a necessary accompaniment to an improved steamer service.' (Part I, par. 200.) The Commission regards as serious the anomaly to which reference has just been made. This consists in the fact that the agreement between the Cuba Submarine and the West India and Panama Companies causes the latter, although it is subsidized by the colonies, to be bound to take a hostile position in regard to the Bermuda Companies, which receive a subsidy from the Imperial Government and are the means of providing a direct and all-British route to Canada. There is the additional matter that the agreement lessens the possibility of competition between such companies in the West Indies, with the exception of Jamaica, so that this useful cause of lowering of rates is eliminated. As regards the West India and Panama Company, particularly, its unsatisfactory financial condition and the small likelihood that the colonies will increase their subsidies, together with other general considerations, convince the Commission that there is no justification for the continued dependence of the West Indian colonies upon this company. Objections are cited against the making of arrangements between the different West Indian cable companies, as regards their traffic. These are: (1) the inevitable creation of a monpoly, owing to the smallness of the business; (2) there should be no suggestion of interference with the installation of wireless telegraphy for the needs of the smaller colonies; (3) it is probable that a recurrence of the present unsatisfactory situation would be the only result; (4) such a commercial arrangement does little or nothing for the facilitation of administration or the bringing of the colonies into closer relationship with one another. (Part I, par. 206.)

The remedy suggested by the Commission is the public ownership and operation of the cables in the British West Indies, and possibly of the whole system northward to Halifax, the arrangement being made by the Imperial Government, at first, in conference with that of Canada. The provision to be undertaken in connexion with such a scheme includes: (1) the duplication, or supplementing by wireless, of the single cable between Halifax and Bermuda, and Bermuda and Jamaica; (2) the laying of a cable between Bermuda and Barbados, with a branch to Trinidad, and perhaps another to British Guiana; (3) the replacement of the cables running from Jamaica to the eastern islands and British Guiana by wireless installations, on account of the unsuitability to cables of this part of the bed of the Caribbean Sea; (4) the connexion of British Honduras and Jamaica by wireless; (5) the provision of small wireless installations to serve the outlying Leeward and Bahama islands.

The report proceeds to a consideration of the conditions surrounding the possible purchase of the property of the companies, and suggests that if public control and management are thought inexpedient, an alternative would be provided by the establishment of an all-British route by one company, through the purchase of the property of, or the making of arrangements with, the other companies.

OBLIGATIONS OF THE MOTHER COUNTRY.

In the opinion of the Commission, it is clear that, for some years to come, the Imperial Government must meet a large part of the annual expenditure which is required in connexion with the steamship service between Canada and the West Indies, the maintenance of the Imperial Department of Agriculture, and the provision of improved telegraph service. As regards these matters, the following definite statement is made: 'With the gravest sense of the responsibility attaching to us, we venture strongly to represent to Your Majesty that the time has not yet come when the assistance which the Imperial Government have granted, since 1897, to the West Indian Colonies can be wholly, or even largely, withdrawn.' (Part I, par. 216.) Figures are given to show the amounts granted by the Imperial Government in aid of the West Indian colonies in each of the thirteen years, up to 1909-10. These are detailed in Appendix II, Part I, and include, among others: (1) grants in aid of the deficiencies of the revenues of the several colonies, between 1897 and 1905, amounting to £214,300; (2) a special grant, in addition, in 1897-8, of £30,000 in aid of roads and land settlement; (3) a grant, also in addition, of £250,000, in aid of the sugar industry, in 1902; (4) grants amounting to £232,000 for providing assistance after hurricanes and earthquakes; (5) a sum of about £177,000, expended during the last twelve years on the maintenance of the Imperial Department of Agriculture and the Botanic Stations; (6) assistance in the provision of steamship subsidies, which included, until 1905, an annual subsidy of £80,000 for the service between the West Indies and the United Kingdom.

One of the obligations of the Mother Country is considered to be the continuation of the Imperial Department of Agriculture, and the following reasons for this are brought forward: (1) the effect of its work in increasing the prosperity of the smaller islands, while making them less dependent on the sugar industry; (2) the development of the cotton industry, which promises to be a valuable asset to some of the smaller islands; (3) the introduction of improved methods of cultivation and the giving of scientific instruction to agriculturists; (4) the fact that the work of the Department cannot have been completed at the present time; (5) the necessity for the further maintenance of a central organization for the initiation and direction of schemes of co-operation among small producers; (6) the necessity for the maintenance of continuity of policy, which makes it essential that the Department shall be established for a definite term of years; (7) the need for its aid, especially from a scientific point of view, in the further extension and development of the production of new crops of various kinds; (8) that the work of the Department, in effecting the increased development of such products renders the results of any disasters in the West Indies less serious, and reduces the necessity for the making of Imperial grants. In regard to the last: 'It can be shown that the Imperial Agricultural Department in recent years has fully justified the expenditure it incurs in the above indirect but no less effective sense.' (Part I, par. 222.)

CONCLUSION.

A memorandum made on the part of Sir John Poynder Dickson-Poynder, Bart., now Lord Islington, and necessitated by his departure to New Zealand to take up the duties of Governor of that Dominion, is attached to the end of the report. The statements in this are in substantial accord with those contained in the main report, from which the following paragraphs near the end may be quoted as a suitable conclusion :—

'The improvement of the means of transport is still an important corollary to the development of minor industries; and the growth of the market in Canada for West Indian products makes it especially important that the communication with the Dominion should be adequate.

'Of the other recommendations of the Commission of 1897, the most important, the abolition of the Continental bounties on sugar, has been carried into effect by the Brussels Convention. This fact, however, does not lessen the force of the remarks contained in the Report of that Commission on the danger of dependence on a single industry, nor does it justify the discontinuance of the efforts that have been made to facilitate the introduction of other industries. We are satisfied that those efforts will be rendered fruitless if the Imperial assistance to the Department of Agriculture is now withdrawn, and if the steamship service with Canada is not continued, and if possible improved.

'We regard the maintenance of this service, and also of the Department of Agriculture, as in a sense an insurance against the recurrence of demands upon the Imperial Government for the restoration of the solvency of the Colonies. It cannot be doubted that if any of these Colonies should again find themselves unable to meet the necessary and unavoidable cost of administration, the question of meeting their liabilities will become a matter for the serious consideration of Your Majesty's Government. In present conditions we consider the development of the trade with Canada will afford the surest guarantee against the recurrence of such a state of affairs; and we repeat that the maintenance of frequent and regular communication is of the essence of such a development.'

MEMORANDUM BY THE IMPERIAL COMMISSIONER OF AGRICULTURE FOR THE WEST INDIES ON THE DEVELOPMENT OF A WEST INDIAN FRUIT TRADE.

1. If a successful fruit trade is to be developed amongst the smaller West Indian islands, many problems have to be solved, and there must be some concerted action, for the interests of one island are too small to evoke the required facilities. It is in securing this concerted action that difficulties largely lie: individual efforts, and even efforts on the part of an island community, have been made from time to time without resulting in great success, their smallness precluding them from making the necessary impression.

2. The subject may be considered from three points of view:—

(1) The production of fruit.

(2) The circumstances of the market in which the fruit is sold.

(3) The means of transport.

3. If Jamaica be excepted, there does not exist in the West Indies a sufficient area under cultivation in fruit for export to warrant the provision of proper fruit-carrying steamers, hence the first difficulty that arises is the question of quantity. In the case of many kinds of fruit, many years would elapse before any large supply could be produced even if a great amount of energy were exerted, and it seems difficult to see how, in these scattered communities, the difficulty of ensuring adequate transport is to be got over in the absence of a sound guarantee that the fruit will at a given time be available for transportation.

4. In the case of the banana, however, this difficulty is not so apparent, for this fruit can be reaped within eighteen months of planting, it approaches an arable crop in character more nearly than any other fruit crop, and the amount of fruit which may be expected within a given time is more readily estimated than is the case with other fruit crops.

5. It would seem, therefore, that the banana will serve as the pioneer fruit for opening up a trade from these parts of the West Indies where fruit-exporting is not yet a business.

6. In the case of British Guiana and Trinidad, there exist large areas capable of being brought under banana cultivation, and their circumstances may be compared with those of Jamaica. Should a real interest in banana-growing be awakened in those colonies, they will be able to produce quantities which will call for special steamers, and the transport question will solve itself on ordinary commercial lines.

7. The circumstances of the smaller colonies require more detailed consideration.

8. An effort to grow and export bananas from Barbados began about 1902, and the results are instructive. The exports were as follows :—

1902	18 bunches.
1903	6,691 „
1904	15,326 „
1905	35,452 „
1906	1,586 „

The industry which appeared to be a most promising one (see *Agricultural News*, Vol. IV, p. 325) suddenly collapsed owing to inadequate steamer transport facilities. The manner in which the industry grew in Barbados is instructive, and indicates what may be expected in Barbados and other islands if conditions favourable for the trade again arise. It has been estimated that the output of bananas from Barbados might be brought up to something like one or two million bunches a year, under favourable conditions.

9. In Grenada and St. Vincent, there are many acres of land where bananas could be grown to advantage; exactly what area could be planted it is impossible to say, for other conditions besides the mere existence of suitable land would influence the planting; but it would not seem a difficult matter, if conditions were favourable, to raise over 100,000 bunches in each island, with a prospect of very considerable increase if the trade were profitable.

10. The same may be stated of St. Lucia ; though here the difficulty of finding labour might retard progress, at first.

11. It should be possible to build up an industry in bananas in Dominica to the extent of 100,000 bunches a year, with a prospect of considerable increase.

12. In the islands north of Dominica, namely, Montserrat, Antigua, Nevis, St. Kitts and the Virgin Islands, it would appear as though the development of a banana trade would depend largely on the development of such a trade in those islands to the south more eminently suited for fruit-growing. If, however, a trade were established, there is reason to suppose that each of these islands would contribute in fair proportion ; each island might be able to export some 30,000 to 100,000 bunches.

13. Reviewed broadly, it may be taken that the West Indian Islands ranging from Grenada to the Virgin Islands may be able to develop a banana trade under favourable conditions which might ultimately reach to some 2 or 3 million bunches a year ; in the early stages the output would be quite small, but if success attended these early efforts, the industry would grow rapidly.

14. If a market can be found within easy access, it is quite possible for the West Indies to develop a trade in citrus fruits. At present, the West Indies hold a very large proportion, if not a monopoly, of the trade in limes and lime juice. A large and growing business in fresh limes is carried on, principally with New York, and vigorous efforts are being made to develop the trade with England. It is felt that much may be done to

secure a market in Canada, where the lime should compete favourably with the lemon. The trade in lime fruits is at present chiefly carried on from Dominica, some quantity also being sent from Montserrat.

15. The cultivation of the lime is steadily extending in the West Indies, and it is sufficient to say that there exists a supply of lime fruit capable of satisfying large demands: any effort to develop this trade may rely upon adequate supplies.

16. Grape-fruits, or pumelows, are grown in most of the islands; they could be produced in quantity in nearly all of them if steps were taken to secure a reliable market. Oranges are also capable of being grown in many of the islands: at present, no very large supplies are available, and the trade is not a well-organized one.

17. With an effort to open markets in Canada for West Indian fruits, grape-fruits and oranges should receive careful attention. The development of a trade must necessarily be slow, for it takes several years for grape-fruit and orange trees to come into bearing. Nevertheless, there already exists a considerable number of bearing trees, particularly in Dominica, so that a trade of moderate dimensions might soon be created; once successfully started, it would grow to one of considerable dimensions.

18. The development of a trade in citrus fruits would speedily follow any development of a banana trade with its consequent regular steamers fitted for the carrying of fruit. Citrus fruits carry well; they require only reasonable care in handling and stowing, and well ventilated and cool holds in the ship carrying them; actual cold storage is not necessary.

19. With the stimulation of interest in fruit production, attention will be given to the production of pine-apples. Some of the islands, particularly Antigua, St. Kitts and Montserrat, though this by no means exhausts the list, are capable of growing pine-apples. Hitherto, the export of pine-apples has been largely confined to peasant-grown fruit from Antigua; this fruit receives but little attention and by no means represents the capacity of these islands to produce fine fruit. It would not be difficult, if sufficient motive existed, to raise crops of 200,000 to 2,000,000 fruits, if markets can be found and transport is secured

20. The establishment of a fruit trade in bananas and citrus fruits would stimulate interest in, and afford facilities for, the creation of a trade in other fruits; amongst these may be mentioned mangos, guavas, and avocado pears. All these are soft fruits which require great care in handling and stowing; it is therefore impossible to hope to establish a trade in fruits of this nature until a regular trade in other fruit is established. Such a trade, however, grafted on to an established trade, is capable of growing to large dimensions and of opening to important possibilities in these islands. I can conceive the growing of such fruits as fine grafted mangos and avocado pears as affording remunerative occupation for a considerable number of people, and forming an important phase of West Indian fruit-farming.

21. Attention is being given to the planting of cocoa-nuts in many islands, so that production is increasing. Cocoa-nuts are readily carried, and do not call for any elaborate system of cool storage.

22. Concurrently with the development of a fruit trade, it will doubtless be found possible to develop some trade in vegetables; this will be a collateral trade following an established trade in such things as bananas. While this possibility should not be overlooked, it need not be elaborated at this point.

23. It may be asked: If all these possibilities exist in the way of developing trade in various kinds, how is it that so little has resulted in this direction from the lesser West Indian Islands?

24. There are several satisfactory reasons why so little progress has been made. The great market of the United States is blocked by reason of tariff restrictions calculated to protect the fruit growers of that country; though it is to be remembered that bananas, plantains, mangos and tamarinds are admitted free of duty. The European market offers difficulties on account of distance, and imperfect communication—judged from a fruit point of view. The Canadian market is unexplored.

25. It is extremely hard to get over the initial difficulties of fruit production when the market lies at any considerable distance: quantities must be produced which command the means of transport; the producer and the buyer are not sure of each other's needs or capacity: there is not that close association which enables the one to supply just when the other requires. All these and many similar difficulties deter isolated individuals from embarking in undertakings which require years before even the prospects of success or failure can be estimated.

26. It may be taken that the difficulties are real and are not the result of ineptitude on the part of West Indian agriculturists and business men. In this connexion, it may be interesting to cite the striking manner in which the cotton industry grew from 1902 to 1907. In the former year the exports were 328,530 lb, valued at £7,366, and in the latter year 2,512,129 lb., valued at £214,776. Or perhaps the more pertinent instance of the growth of the banana industry in Barbados may be referred to. This industry began in 1902, with an export of 18 bunches, in 1905 the export reached 35,450 bunches, and then fell off for want of proper facilities. These facts go to show that if adequate facilities and markets are provided, West Indian agriculturists will be quick to take advantage of them.

27. It will be difficult, if not futile, to attempt to establish a fruit trade without making definite arrangements with the buyers beforehand. In an attempt to develop a fruit trade with Canada, I suggest that particular attention be given to the possibility of grouping and organizing the interests of the buyers in their relations with the West Indies

28. To this end, an effort should be made to unite the buyers and induce them to indicate to the West Indies what fruit it is desirable the West Indies should endeavour to produce, what quantities are required, at what times it is most acceptable, and in what form it should be shipped. The associated buyers should undertake to purchase, at reasonable market rates, certain quantities of fruit of standard quality.

29. The associated buyers would facilitate business enormously if they would send a reliable agent to the West Indies, who would meet the fruit growers and, if possible, arrange to purchase the fruit in the islands themselves. Trade would rapidly grow if the associated buyers purchased the fruit, packed and shipped it. Such a system would enable large and small growers to enter the business; it would mean that the fruit would be properly selected, graded and packed, and the associated buyers would constitute a body of sufficient importance to manage matters relating to transport and distribution by means of steamships and railways in a manner which would be impossible at the hands of small, isolated dealers.

30. The organization of buyers into a body interested in the development of a West Indian fruit trade appears to be as important a step as the creation of a number of fruit growers, and efforts directed to this end are most desirable.

31. It is conceivable that the interests of the growers might be protected by introducing some element of co-operation into the scheme, whereby the growers received some share of profits. Or their interests might be watched by a West Indian Trade Commissioner, resident in Canada.

32. It is not possible within the limits of space of this memorandum to attempt to set out details of a scheme, but it may be taken for granted that the agent of the associated buyers would be able to travel at small cost by the steamers engaged in the fruit trade, while the appointment of local agents, who would be paid to some extent by results, would permit of the establishment, at a reasonable cost, of a far-reaching system.

33. It is not to be expected that such a system of local purchasing and supervision would prove remunerative at the outset, but its establishment would permit of the steady building up of a remunerative trade, which should ultimately be of very great value to all concerned.

34. It should be possible for the Imperial Department of Agriculture to play a useful part in assisting the organization of a fruit trade. It can supply information to growers and buyers and, at least in the early stages, act as general adviser and intermediary.

35. In the early stages of the development of the trade, it is essential to face the question that the steamer transport of the fruit would not present business that would be attractive to shipping companies; it seems therefore necessary that inducements shall be offered by way of subsidies. If this is done, it may be well to discriminate between a general subsidy for the provision of steamship accommodation and a specific subsidy for carrying fruit. If only a general subsidy

is paid, there is some risk of the steamship company failing to foster a fruit trade which, at the outset, would be troublesome and probably unremunerative. This would be got over by reserving a portion of the subsidy to be paid specifically in respect of fruit carried and landed in good order.

36. The arrangements for fruit transport on board ship necessitate the installation of methods for cool storage, whereby the holds for fruit can be kept thoroughly ventilated and a temperature down to about 40° F. can be secured and maintained; actual freezing is not necessary. If certain holds are fitted with these arrangements, it does not preclude their being used for other cargo, not requiring cool storage, until such time as a supply of fruit comes forward. When this happens, the specific subsidy for fruit carrying should be sufficient to induce the ship-owners to wish to carry the fruit as profitable cargo.

37. If the fruit holds are used for other cargo it is essential that when fruit comes forward they shall be quite clean and free from smell, for some kinds of fruit, particularly bananas, are very liable to damage from taint. Ships trading between Canada and the West Indies carry some kinds of cargo, such as salt fish, sugar and molasses, calling for particular attention in this connexion.

38. For the purposes of a successful fruit trade, it is desirable that the means of shipping at least once a week should be available; it is difficult to secure fruit in good shipping condition, if the intervals are much longer.

39. The conclusions may be summarized thus:—

The West Indies are capable of producing large supplies of fruit, if arrangements can be made for transport and sale.

Bananas are the fruit most quickly grown; they would, in the first instance, form the bulk of the trade. Citrus fruits, grape fruits, oranges and limes would come next in importance. Pine-apples should have an important place. A trade in soft fruits would develop when regular communication was established.

The grouping and organization of the buyers, with respect to their interest in West Indian fruit, is an important factor in developing a fruit trade. The best results will follow if the buyer can make his purchases in the West Indies and undertake the packing and shipping.

Regular steam communication at frequent intervals is essential, and the steamers must be fitted with cool, not cold, storage. The payment of a portion of any subsidy specifically for carrying fruit is desirable.

(Sgd.) FRANCIS WATTS,
Commissioner of Agriculture
for the West Indies.

Barbados,
April 5, 1910.

REPORT ON A MISSION TO CANADA AND NEW YORK.

I have the honour to submit the following report on my visit to Canada and New York, as official representative of The Imperial Department of Agriculture for the West Indies.

The objects of my mission were: (a) to assist in arranging the West Indian exhibits at the National Exhibition at Toronto, and the Dominion Exhibition at St. John, N.B., and to afford information to visitors concerning the resources of the various colonies, and their capacities for trade; (b) to report concerning the nature of the West Indian exhibits, the manner in which they were displayed, and the general effect which they were calculated to produce from a business point of view; (c) to make enquiry concerning the possibility of increasing the trade with Canada in fruit, cacao, arrowroot, spices, starches, cotton, and West Indian produce generally; (d) to obtain information in New York concerning the conditions and requirements of the trade in fresh limes, and the probability of the British West Indian trade in this product being seriously interfered with by supplies from Porto Rico, Florida, Cuba, and Mexico.

I left St. Vincent for Barbados on August 8, and reported myself at the Head Office on August 9. I discussed matters in connexion with my mission and received instructions from the Imperial Commissioner. On his representation, Messrs. Pickford & Black kindly granted me a free first class passage to St. John, N.B., and on the same evening I sailed for Canada on the S.S. 'Sobo'.

The steamer stopped at St. Lucia, Dominica, Antigua, and St. Kitts on the voyage north, and I took the opportunity to visit the Officers administering the Governments in each island and also the local officers of the Department, with the exception of St. Kitts, at which island the stay of the steamer was too short to permit me to land. I, however, met the Agricultural Superintendent of St. Kitts-Nevis in Antigua, and discussed matters with him. In Antigua I also attended a meeting of the Agricultural and Commercial Society and met a number of merchants and planters. At all the islands visited I made enquiries in regard to the exhibits sent to Canada, and local products generally.

A call was made at Bermuda. I had hopod to obtain information here in reference to the market for West Indian limes and the local arrowroot industry, but owing to the short stay of the steamer, only a very brief enquiry could be made. In regard to West Indian limes, I was informed that the supply during the past few months had been short of requirements. Bermuda offers a good market for fresh limes, and the demand is likely to increase considerably in the near future; for large additions to hotels were being made to deal with the increasing American and Canadian tourist trade. In addition, a new feature was the exceptional inducements offered to tourists by the Royal Mail Steam Packet Company, and the Quebec Steamship Company, to visit the island during the summer and autumn months. I understood that a large number of persons is paid, there is some risk of the steamship company failing to foster a fruit trade which, at the outset, would be troublesome and probably unremunerative. This would be got over by reserving a portion of the subsidy to be paid specifically in respect of fruit carried and landed in good order.

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The objects of my mission were: (a) to assist in arranging the West Indian exhibits at the National Exhibition at Toronto, and the Dominion Exhibition at St. John, N.B., and to afford information to visitors concerning the resources of the various colonies, and their capacities for trade; (b) to report concerning the nature of the West Indian exhibits, the manner in which they were displayed, and the general effect which they were calculated to produce from a business point of view; (c) to make enquiry concerning the possibility of increasing the trade with Canada in fruit, cacao, arrowroot, spices, starches, cotton, and West Indian produce generally; (d) to obtain information in New York concerning the conditions and requirements of the trade in fresh limes, and the probability of the British West Indian trade in this product being seriously interfered with by supplies from Porto Rico, Florida, Cuba, and Mexico.

I left St. Vincent for Barbados on August 8, and reported myself at the Head Office on August 9. I discussed matters in connexion with my mission and received instructions from the Imperial Commissioner. On his representation, Messrs. Pickford & Black kindly granted me a free first class passage to St. John, N.B., and on the same evening I sailed for Canada on the S.S. 'Sobo'.

The steamer stopped at St. Lucia, Dominica, Antigua, and St. Kitts on the voyage north, and I took the opportunity to visit the Officers administering the Governments in each island and also the local officers of the Department, with the exception of St. Kitts, at which island the stay of the steamer was too short to permit me to land. I, however, met the Agricultural Superintendent of St. Kitts-Nevis in Antigua, and discussed matters with him. In Antigua I also attended a meeting of the Agricultural and Commercial Society and met a number of merchants and planters. At all the islands visited I made enquiries in regard to the exhibits sent to Canada, and local products generally.

A call was made at Bermuda. I had hoped to obtain information here in reference to the market for West Indian limes and the local arrowroot industry, but owing to the short stay of the steamer, only a very brief enquiry could be made. In regard to West Indian limes, I was informed that the supply during the past few months had been short of requirements. Bermuda offers a good market for fresh limes, and the demand is likely to increase considerably in the near future; for large additions to hotels were being made to deal with the increasing American and Canadian tourist trade. In addition, a new feature was the exceptional inducements offered to tourists by the Royal Mail Steam Packet Company, and the Quebec Steamship Company, to visit the island during the summer and autumn months. I understood that a large number of persons were taking advantage of the special trips organized. Growers of limes are therefore advised to keep in close touch with this market. The small arrowroot industry is carried on by one firm only. The arrowroot exported goes into a special trade, and the demand is limited. There was not likely to be any extension of planting. In regard to the arrowroot roots sometimes imported from St. Vincent, I ascertained that they were used solely for planting purposes.

I arrived at St. John, N.B., on August 22. On landing I received a letter from Messrs. Pickford & Black, Halifax, advising that I should proceed to Toronto at once : if I were to assist in arranging the West Indian exhibits at that city, I should proceed without delay. A free first class, railway pass to Toronto via Montreal was enclosed. I therefore decided to leave St. John, N.B., by the evening train. Next day I spent a good deal of time in helping the Agents of the Pickford & Black Steamship Company to assort the large number of cases containing the exhibits landed here for the Toronto and St. John exhibitions. Nearly all the cases were addressed to Messrs. Pickford & Black, Halifax: notwithstanding, all were landed at St. John, and all correspondence in connexion with the exhibts had been addressed to Halifax. It was impossible to determine in many instances, which cases were determined for the Toronto Exhibition, and which for St. John, as they bore no distinguishing marks. Indeed, on some of the packages no address or mark could be found. An endeavour was made to find out from which island the unmarked cases were sent, what were their contents, and where they should be sent; but here again information was lacking. It will be readily understood from the above that it was impossible to properly assort the packages. Besides, in the warehouse where they were placed there were hundreds of other cases and boxes which added to the difficulty of assorting those from the West Indies. The result was, that a few cases of exhibits intended for Toronto remained at St. John, and others for St. John, went on to Toronto. To avoid a recurrence of this unsatisfactory state of affairs, I would suggest that in future all cases of exhibits be addressed in large letters to the steamship agents at St. John, or at whatever port they are to be landed, and not to the head office of the Steamship Company, if such office is at some other place. Then again, the name of the exhibition to which the cases are to be forwarded should also be clearly displayed, together with the country of origin. For instance, a case from St. Lucia for the National Exhibition at Toronto would under present steamship arrangements be addressed as follows :—

No. 1. THE AGENTS,
PICKFORD & BLACK S.S. Co.,
ST. JOHN, N.B.

St. Lucia exhibits for the Toronto Exhibition.

A list giving the number, description, and contents of the packages shipped from each island should also be addressed to the steamship agents, so that it could be used for purposes of checking.

THE CANADIAN NATIONAL EXHIBITION, TORONTO.

Before leaving I called, as directed by the Imperial Commissioner, on Mr. H. B. Schofield and stated the object of my mission and he kindly offered to assist me in any way possible, on my return.

I reached Toronto on the morning of the 24th, and met Mr. C. S. Pickford, who was in charge of the West Indian exhibits. After arranging for hotel accommodation, I proceeded to the exhibition grounds with him. I found that the British West Indies had been allotted space measuring, 100 feet by 24 feet in a large permanent, well-lighted building known as the 'Agricultural Hall'. This building was in an excellent position close to the main entrance of the exhibition. Mr. Pickford had already started to erect stands, but there was still a good deal to be done. From the 24th to the 28th I assisted in the work of building the stands, unpacking and staging exhibits, and decorating the Court.

Owing to a recent strike on the Grand Trunk Railway, the Canadian Pacific Railway, just at this time, had a large quantity of extra freight to deal with. This prevented us from getting all the cases of exhibits through from St. John, N B., in time for the opening of the exhibition The bulk, however, were received in good time. I should mention here, that the distance by rail from St. John to Toronto is 825 miles, and that cases properly addressed came through two days earlier than others not well marked.

Exhibits were received from Trinidad, Barbados, St Lucia, St. Vincent, Antigua, Montserrat, and British Guiana. Unfortunately, the St. Kitts-Nevis and Virgin Islands exhibits were not received, owing, I was informed by Mr. C. S. Pickford, to the fact that the cases were not fully addressed.

CONDITION OF EXHIBITS WHEN UNPACKED.

The following notes were made on the condition of the exhibits from the different colonies, when unpacked.

TRINIDAD.—Glass jars received in good order; contents not damaged. Cacao pods wrapped in cotton wool, packed in tins, and preserved by means of formaldehyde vapour—in good order. Suggest that some other wrapping material be used in future, as cotton wool adheres to the pods and cannot be readily removed. The pods had to be soaked in water for some time, and then scrubbed.

BARBADOS.—Bottles containing exhibits well packed in cases with partitions. In excellent order - only one or two breakages. One bottle of molasses exploded on being handled. Yams and sweet potatos packed in well ventilated barrels—in good order. Cotton samples in glass topped boxes also arrived safely.

ST. LUCIA.—Exhibits in glass jars and bottles were packed in kerosene boxes, several jars broken. Boxes were not large enough: not sufficient space allowed for packing. Several jars with liquids leaking. Limes were inferior in quality; not well assorted, many discoloured with scale insects and black blight.

I did not consider it wise to exhibit them. Sugar, etc., in glass-topped boxes in good order. Bananas in crates all bad.

ST. VINCENT.—Exhibits in jars and bottles well packed. One or two jars with syrup and molasses leaking, Yams packed in a case in good condition, but other vegetables in same case rotten. Case required more ventilation glass. topped boxes carried well.

ANTIGUA.—A considerable proportion of the exhibit received was in poor condition. Bottles with liquids leaking. All sound bottles had to be washed. Fruit, vegetables, cocoa-nuts, bottles. and boxes all packed together in a case arrived in bad order. Specimens of Turk's cap cactus good.

MONTSERRAT.—Preserves and essential oils in bottles in excellent condition,—well packed. Other exhibits in boxes sound.

BRITISH GUIANA.—Exhibits arrived safely and in good condition. They were all well packed in strong cases and crates.

It will be seen that the exhibits from Trinidad, Barbados, Montserrat, and British Guiana arrived in good order, as also did those from St. Vincent, with the exception of one case of vegetables. This was due to careful packing in strong cases and crates.

In regard to the Antigua and St. Lucia exhibits, the damaged condition in which some of them arrived must be ascribed to faulty packing.

The following points should receive attention when exhibits for future shows at Toronto or other inland Canadian cities are being packed :—

(*a*.) Only strong cases and crates should be used. Besides the handling in shipping and unshipping, the packages receive rough usage on railways, etc. before they reach their destination.

(*b*.) In cases for bottles, allow space for plenty of packing material.

(*c*.) Bottles containing liquids should not be placed in cases with bottles containing dry products. Syrups and molasses almost invariably leak out of bottles in transit. Several dry exhibits were damaged by these liquids.

(*d*.) Under existing transport conditions by sea and land, exhibits of fruit other than limes, oranges, and grape-fruit do not carry well, and therefore should not be sent in any quantity. Citrus fruits such as those named, provided they are carefully selected and packed, travel fairly well; but even then, there is usually a loss of about 20 per cent.

ARRANGEMENT OF WEST INDIAN COURT.

The West Indian Court presented a very attractive appearance. The exhibits from the islands and British Guiana were placed inside a structure 100 feet long 24 feet wide and 8 feet high, built of turned wooden columns, surmounted by a plain cornice, and painted white and green. The names of the colonies exhibiting were painted in large letters on the cornice in front of the stands on which the respective exhibits were displayed.

The stands for the exhibits, which were of different shapes and sizes suited to the uses for which they were required, were painted white and draped with green burlap. The exhibits were arranged on these in tiers, as far as possible. Loans of suitable tropical plants to provide decorative material were made to a great extent by the Exhibition Authorities. This was a special concession, highly appreciated. The rest of the decorative material such as palm leaves, and sugar-canes, was provided by certain of the colonies.

Although not originally arranged to provide space for the Jamaica exhibit, it was found possible to allot about one-third of the Court to the exhibit from that Colony.

DESCRIPTION OF EXHIBITS FROM EACH COLONY.

JAMAICA.—This colony sent the largest exhibit. It occupied the southern portion of the Court and was under the charge of Mr. E. J. Wortley, F.C.S. The chief exhibits consisted of economic plants in flower and fruit, such as coffee, cacao, oranges, and vanilla ; jippi-jappa hats in all stages of manufacture, with specimens of the straw from which they are made and a good sample of the growing plant (*Carludovica jamaicensis*) which provides this. Cigars and tobacco ; sugars, molasses and rum ; cacao, coffee ; fruits, such as bananas, grape-fruit, oranges and mangos ; spices ; curios including seed work and lace bark ; and a large number of photographic views of the island were also shown.

The exhibits were suitably displayed and of considerable interest to visitors.

An illustrated descriptive catalogue containing general information in regard to the products and resources of the island, and also a list of the exhibits, was distributed.

TRINIDAD.—The exhibits from this colony were confined to cacao. They were arranged in five sections at the northern end of the Court. The first showed germinating beans, living plants in bamboo pots, cacao pods, herbarium specimens, and a large number of photographs illustrating the cacao industry, and views of the island. The second and third consisted chiefly of samples of cured cacao of different grades from well known estates. The fourth included the products of the cacao bean as prepared for manufacturing purposes, together with samples of cacao powder and chocolate. In the fifth were displayed the different varieties of Trinidad cacao. In the centre of the exhibit several small tables with chairs were arranged at which hot Trinidad cocoa was served to visitors. Samples of cacao powder, manufactured from Trinidad cacao, were also distributed. In this section, considerable assistance was rendered by representatives of Messrs Cowan & Co., the well-known cacao manufacturers of Toronto.

Although not representing Trinidad officially, I assisted in arranging the exhibit and took charge of it during the greater part of the time that the exhibition was open. From the statements of a large number of people, and the enquiries made, I am in a position to state that the exhibit attracted much attention. It was of high educational value, and a good advertisement for the Colony's principal industry.

BARBADOS.—The exhibits consisted chiefly of sugars, molasses, rums, cotton seed oil, manjak, infusorial earth, cotton, yams, and sweet potatos, and a collection of framed photographic views of the island. A catalogue of the exhibits was distributed.

The exhibits which attracted most attention were sugars, especially centrifugalled muscovados; molasses, syrups and rums; yams and sweet potatos. All the samples sent were good ones of their kind, and were effectively put up, and labelled. Taken altogether, the Barbados display was an excellent one in every respect.

ST. LUCIA.—This island sent a comprehensive collection of samples of the products of the island such as sugar, rum, molasses, syrup, lime juice, cacao, cassava and arrowroot starches, honey, musk seed, spices, Sea Island cotton, vanilla, coffee, slabs of native furniture woods, whole fruits in formalin, limes and bananas.

Reference has been made already to the condition in which the limes and bananas arrived. The other exhibits with the exception of certain preserves were, on the whole, satisfactory. Special mention should be made of the good samples of tropical fruits preserved in formalin. These were of much interest to visitors. The dry products in boxes and bottles also made a very creditable show.

Copies of an illustrated pamphlet describing the island, its products and resources, were distributed to visitors.

ST. VINCENT.—Among the exhibits from this colony were samples of fine Sea Island cotton, arrowroot, sugars, molasses, rum, cacao, vanilla, preserves, pickles, yams, and seeds of a decorative nature. The exhibits, which were put in bottles, jars, and glass-topped boxes, arrived in excellent condition and were effectively displayed. They commanded a good deal of attention throughout the show. The clear and distinct labelling of these exhibits calls for special mention.

ANTIGUA.—Unfortunately, a good number of the exhibits from this island arrived in an unsatisfactory condition; there were, however, good samples of sugars and molasses, and cotton seed, native baskets and seed work, and excellent specimens of the interesting Turk's-cap cactus (*Melocactus communis*).

The sugars and molasses attracted the attention of business people; the basket and seed work and the cactus, that of the ordinary visitor. The exhibits were displayed to the best advantage possible, under the circumstances.

MONTSERRAT.—Notwithstanding that they were small in number, the exhibits from Montserrat created a great deal of interest. They consisted chiefly of fresh limes, lime juice, preserves, Sea Island cotton and essential oils.

A most effective pyramid of excellent limes was exhibited in a prominent position, and free samples of the fruit were distributed. It might be safely said that the exhibit of Montserrat limes was one of the most attractive features of the Court, and as an advertisement, left nothing to be desired. The preserves were good, and were exhibited in small bottles, neatly labelled. The exhibits of guava jelly were very good but 'guavarina'—packed in boxes, and 'guavas in syrup' started fermenting towards the close of the exhibition.

BRITISH GUIANA.—Chief among the material sent from this colony were, sugars, molasses, molascuit and rum; rices, citrus fruits, cacao, coffee, large logs of greenheart and specimen blocks of native woods, confectionery, and a large map of the Colony.

It was expected that a special representative of the colony would have been present to arrange the exhibits, but it was three days after the opening of the exhibition when a representative of the West India Company, Montreal, arrived to assume charge. In the meantime Mr. Pickford and myself did what we could in the matter of arranging and staging the samples, but they were not as effectively displayed as those from the other colonies.

MESSRS. PICKFORD & BLACK'S ADVERTISEMENTS.

On the wall of the Court, at a height of 10 feet, were placed at intervals white sheets on which advertisements in black letters were printed. These advertisements were intended to convey to visitors the advantages to be derived from a trip to the West Indies, during the winter months, in Messrs. Pickford & Black's steamers. Being placed at a reasonable height above the exhibits, they did not affect the attractiveness of the Court, but at the same time they undoubtedly drew attention to the West Indies as a tourist resort.

PUBLICATIONS.

Several thousand copies of the booklet compiled by the Imperial Department of Agriculture and entitled 'The West Indies in Canada, 1910' were distributed to visitors. The publication was of much interest and value. It contained a large amount of information in connexion with the trade between Canada and the British West Indies, and the products and resources of the different colonies. It was specially useful in dealing with enquiries made by business men.

Besides the booklet, a large number of post-cards, leaflets, and catalogues of exhibits were given to persons interested in the products of different colonies. Advertising matter such as the above was supplied by Trinidad, Barbados, St. Lucia, St. Vincent, and British Guiana.

In order to ensure that persons interested in particular products obtained accurate information, a large notice was placed in a prominent position on which was printed :—

> 'Persons desiring information in regard to the West Indian Exhibit, please ask for Mr. C. S. Pickford or Mr. W. N. Sands.'

This had the desired effect.

The National Exhibition, as is well known, is the most successful annual exhibition held on the North American Continent. It was attended this year by 800,000 persons. The attendance shows a progressive increase each season. The exhibition was well organized, and even attracted people from districts situated at long distances from Toronto. There was also a large number of American visitors. The show was opened on August 27, and closed on September 9. All the exhibits likely to be affected by inclement weather were placed in large, well built permanent buildings.

The British West Indian exhibit was, as mentioned before, allotted a good position in a building known as the Agricultural Hall. In this building, there were also very fine exhibits from British Columbia, Ontario, Alberta, and other Canadian Provinces. Notwithstanding that large sums of money were expended by these provinces on making their respective exhibits attractive, it was conceded that the display made by British West Indies was the most interesting and instructive in the building.

The Court was thronged by visitors each day from 8 a.m. until 10 p.m., and it will be readily understood that those in charge had an exceedingly busy time answering questions and affording information generally.

The exhibition authorities, in view of the fact that the exhibit was collected and sent by official bodies in the different colonies, made no charge for space. I might mention here, that at this exhibition there is always a great demand for space by manufacturers and others, in fact, the demand cannot be fully met, and had the space allotted to the British West Indies been rented, the authorities could readily have obtained £500 for it. These colonies are therefore particularly fortunate in obtaining such a valuable concession.

THE VALUE OF THE BRITISH WEST INDIAN EXHIBIT.

It must be admitted that the larger number of people who visited the Court appeared to have little or no knowledge of the British West Indies, or the products of the different colonies, so that from an educational standpoint the exhibit was a very valuable one.

A good number of representatives of business firms desired information, but not as many as I had anticipated. I, however, answered many enquiries made by business people in connexion with the following products: sugars, (grey crystals and centrifugalled, and grocery muscovados), molasses (especially low grades for cattle food etc.), limes and lime juice, starches (arrowroot and cassava but more particularly cassava), broom corn, cacao, and preserves chiefly guava jelly and tamarinds. In each case as much information as possible was given, and the names and addresses of exporters supplied.

I found it difficult to get hold of business people, with the Court so crowded at all times with ordinary visitors. The plan I adopted of spending an hour or two each morning in the city calling on people at their places of business, drawing attention to particular products in which they might be interested, and referring them to samples which could be inspected at the exhibition, appeared to be a satisfactory method of making certain products known, besides adding to the value of the exhibition from the West Indian standpoint.

Several people desired information on the British West Indies, from the tourist point of view. Apparently the chief drawback to the tourist trade was the unsatisfactory class of steamers at present running to the West Indies from Canadian ports. With better steamers, it appeared likely that a much larger number of Canadians would visit these islands during the winter months.

Considering the large number of people who annually visit the exhibition, and the excellent advertisement, at such small cost, that the British West Indies obtain for their products, I am of opinion that it is desirable that these colonies should continue to exhibit at the Toronto National Exhibition. To abstain from exhibiting now would be unwise, especially as so much attention is being directed to trade between Canada and the West Indies. Canada is developing by leaps and bounds; the demand for West Indian products will increase rapidly, and undoubtedly one of the best means of making those products known to Canadians is through this exhibition.

SUGGESTIONS FOR FUTURE EXHIBITIONS AT TORONTO.

Mr. C. S. Pickford has for several years taken charge of, and arranged, the exhibits sent from the British West Indies. Notwithstanding that he is a capable organizer, and a hard worker, he found it necessary to ask that this year an official representative of the Imperial Department of Agriculture be sent to assist him in arranging the exhibit, and to afford information to visitors. This request was acceded to. From personal experience of the nature of the work that had to be performed and the large amount of information desired by visitors, the request was without doubt a very reasonable one, and, further, I am of opinion that in the interests of the British West Indies an official representative should always attend these exhibitions when a large collective exhibit is forwarded. Besides helping to arrange and display the exhibits to the best advantage, it is necessary for some one who knows the West Indies well to be present to answer enquiries and to give reliable information to visitors concerning the products and resources of the various colonies. Unless such a person is present, the value of the exhibit is reduced to a considerable extent. The usefulness of the representative could be increased by requiring him to visit manufacturers and others during his stay in Canada, with a view to increasing trade in particular products.

A large coloured map of the West Indies should always be sent and placed in a central position in the Court. This map should show the position of the islands in relation to North and South America. The British islands should be drawn on a somewhat exaggerated scale, and brightly coloured. Besides the names of these islands, the area of each, and the chief products might also be clearly shown.

I was astonished to find that a very large number of visitors had little or no knowledge of the West Indies, so that a map, such as above described, would be of considerable educational value.

Then there should be formed in the Court a 'Bureau of Information' well supplied with booklets, pamphlets, post-cards, catalogues, etc., for distribution to interested visitors. Under existing conditions, it often happens that a good deal of valuable advertising matter is taken by children and others to whom it can be of little use, and is therefore to all intents and purposes wasted.

The labels placed on the exhibits should be as informative as possible. In addition to the name of the colony and exhibitor, prices for commercial quantities should be given, together with any other information likely to appeal to possible buyers. Of course, quotations for such products as sugars, cacao, etc., are unnecessary, as the market prices are usually well known. I therefore refer more particularly to prices for such articles as fruit, spices, native woods, preserves, seed work, yams, sweet potatos and curios.

Plants in tubs should not be forwarded, owing to heavy railway charges. Living plants invariably suffer considerably on the long journey from the West Indies to Toronto, and by the time they reach the exhibition they are scarcely worth exhibiting. Decorative material such as palm leaves, bamboos, sugar-cane and sugar-cane arrows might however be sent, in limited quantity.

I left Toronto for St John, N.B., via. Montreal, on September 7. During my stay I had an opportunity, as previously mentioned, of calling on a number of business firms. I arrived at Montreal on September 8, and left for St. John, N.B., on the evening of September 10. At Montreal, I devoted my time solely to visiting firms interested in West Indian produce. I arrived at St. John, N.B., on Sunday, September 11. I propose to give the views of, and the information obtained from, business people at Toronto, Montreal, and also St. John, N.B., in a separate part of this report.

THE DOMINION EXHIBITION, ST. JOHN N.B.

This exhibition was opened on September 5, and closed on the 15th; Mr. C. S. Pickford was in charge of the exhibits sent from certain of the British West Indian Islands and British

Guiana. He left Toronto on August 31 to arrange them, and returned on September 7. I arrived at St. John, as stated above, on September 10, and took charge of the Court until Mr. Pickford returned from Toronto.

The exhibition was a fairly large one, and was attended by 124,000 people.

The British West Indian exhibit was situated on the upper storey of the main permanent exhibition building. The space taken up measured 50 feet by 18 feet. It was not well lighted. The arrangement of the Court was carried out on similar lines to that of Toronto, but on a much smaller and less elaborate scale. At the back of the Court, Messrs. Pickford & Black had a large advertisement similar to their advertisements at Toronto, but owing to the small size of the Court, and low roof it was more conspicuous than those at the National Exhibition.

Exhibits were received and staged from Barbados, Dominica, St. Lucia, St. Vincent, Antigua, Montserrat, St. Kitts-Nevis, Virgin Islands, and British Guiana.

The St. Kitts and Virgin Islands exhibits were originally intended for exhibition at Toronto, but did not arrive there.

The exhibits from the other colonies were practically duplicates of those sent to Toronto, which have been described already.

Dominica was represented at this exhibition but not at Toronto.

The exhibits from all the colonies with the exception of those from Antigua were received in good condition. As Dominica, St. Kitts-Nevis, and the Virgin Islands were not represented at Toronto, it may be well to give a description of the exhibits sent from these places.

DOMINICA.

An excellent collection of exhibits, well prepared and displayed. The collection included good samples of cacao, coffee, spices, starches, limes, lime juice, citrate of lime, essential oil of limes and otto of limes, grape-fruit, Washington Naval oranges, and Carib baskets.

Fruits of good varieties of grafted mangos were sent, but could not be exhibited, as they had rotted on the voyage.

A large pyramid of limes was built and placed in a prominent position, and samples were given to visitors during the whole time the exhibition was open. The limes arrived in excellent condition. They were bright and clean, and well selected. The Washington Navel oranges and grape-fruit were also good. Had these exhibits been shown at Toronto they would have commanded more attention from persons interested than they received here. It is doubtful if they received the attention they deserved. The interest in the British West Indies exhibit, as a whole, appeared to me to be somewhat lukewarm.

ST. KITTS-NEVIS.

The exhibits from this Presidency were well selected and prepared. Among them were good samples of sugars, molasses, rum, preserves, pickles, tamarinds in syrup, cotton seed meal, cotton seed cake, and cashew nuts. There was also sent a growing plant of sugar-cane. The exhibit, as a whole, was a very creditable one.

VIRGIN ISLANDS.

From these islands were sent exhibits of cotton, coffee, cacao, starches, concentrated lime juice, and rum. The samples were as a rule well prepared, and of interest.

I was present at the court on three days—September 12, 13, and 14—and during that time the visitors appeared to be mostly sight-seers. Very few business men made enquiries, so that I do not consider that the effort made by the colonies at this exhibition is likely to have the result anticipated; that is, to lead to any considerable increase in trade. It is true that a large number of people were interested in certain of the exhibits because they appeared strange and curious, and desired their names and uses; therefore, from an educational standpoint, the display was no doubt of value.

NOTES CONCERNING BRITISH WEST INDIAN PRODUCTS IN CANADA, AND THE POSSIBILITY OF INCREASING TRADE.

As was stated in the earlier part of this report, I was instructed to make some enquiry, in the limited time at my disposal, concerning the possibility of increasing the trade in fruit, cacao, arrowroot, spices, starches, cotton, and West Indian products generally. Enquiry was therefore made at Toronto, Montreal, and St John, N.B., the three cities visited.

Owing to Mr. Pickford having to go to St. John, N.B., it was necessary for me to be in constant attendance at the National Exhibition, so that I was only able to spend a very short time of certain days in calling on business firms at Toronto. At Montreal, I spent three days going into various questions, but my work was hampered owing to the fact that just at this time the Eucharistic Congress was in session. At St. John, N.B., during the three days I was there, I called on several firms, and obtained a certain amount of information from them.

At the National Exhibition, and also at the Dominion Exhibition, but more especially at the former, I discussed matters in connexion with various products with a number of business men.

The Royal Commission on Trade Relations between Canada and the West Indies had recently gone very fully in the possibility of increasing trade in the principal exports of the West Indies, so that I devoted my attention more particularly to products which are not as yet so well known.

FRUIT.

Before leaving Barbados the Imperial Commissioner handed me a copy of the memorandum submitted by him to the Royal Commission on the development of a West Indian Fruit Trade. In that memorandum the subject is discussed under three heads :—

(*a.*) The production of fruit.

(*b.*) The circumstances of the market in which the fruit is sold.

(*c.*) The means of transport.

Taking it for granted that a large quantity of fruit could be produced annually in the West Indies* and that the improved transport facilities are likely to be provided, it may be well to discuss the circumstances of the markets in the Canada cities visited. The business in tropical fruit is a very large one. Fruit is brought into Canada from the West Indies, Panama, Cuba, Porto Rico, Central America, and Surinam, via the United States. California produce is also sent in in large quantities. The markets are well supplied with bananas, grape-fruit, oranges, and lemons by large American fruit companies. The business is thoroughly well organized from start to finish, and at the time of my visit, fruit such as bananas and grape-fruit was both cheap and plentiful. At Montreal I saw good bananas quoted at 10c. to 12c. per dozen, and Jamaica grape-fruit at 6 for 25c. There is no duty on this fruit, and it appears unlikely, in view of the apparent trend of Canadian opinion in favour of reductions in the tariff, where possible, that any additional duties would be imposed ; although in the case of oranges, grape-fruit and limes, the Royal Commission in their report (par. 89) mention that 'Canada having made these fruits free would naturally desire to continue that policy, but, on the other hand, we do not think the item is regarded as one of much importance in Canada, and if the adoption of a small duty on foreign fruit while leaving West Indian fruit on the free list would help to secure the co-operation of any West Indian Colony which might otherwise be unlikely to come into the agreement, it is probable that Canada would be willing to make such an arrangement.' In the absence of duty on foreign fruit, it would appear difficult to organize an association of Canadian fruiterers strong enough to compete successfully against the American fruit corporations. However, there is another factor which may help to turn attention to certain of the West India Islands, as a source of supply of bananas, for the banana, after all, as is stated in the memorandum referred to, is likely to be the pioneer fruit in opening up a fruit trade—I refer to the very serious disease known as 'Panama Sickness' which is said to be destroying the banana plantations of Central America, and Surinam, and one for which there is apparently no remedy. Should this disease continue to spread, the supply of bananas will be short of the requirements, and prices will rise considerably, making it perhaps worth while for Canadian fruiterers to combine for the purpose of developing a fruit trade between Canada and the British West Indies. Undoubtedly, several of the islands could successfully grow large quantities of bananas, provided the business was properly organized; and what is more, no disease is known. In Trinidad, it is true, a disease exists, but the other islands have already strict quarantine regulations in force to prevent its introduction from that island, or elsewhere.

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* Leeward and Windward Islands, Trinidad and Barbados.

The banana business is a very large one, which would require a much larger time than I had at my disposal to go into thoroughly. The trade in grape-fruit, oranges and lemons is also well organized. The California fruit seen on the markets was well graded and packed. Several wholesale fruiterers complained of the manner in which some of the West Indian fruit was graded, and the poor appearance of it. There is no doubt that careful grading and packing of all fruit for the Canadian markets are of the greatest importance. Fruit badly graded and packed cannot be sold, except at a loss.

In any effort having for its object the development of trade in West Indian grape-fruit, oranges, limes, and other fruit, it would, of course, be necessary to study carefully the market requirements in regard to the class of fruit desired, the best time of the year to send it, and the most suitable methods of packing. This could be better performed by a fruit association, working on extensive lines. Individual effort, as was frequently pointed out to me, had too often ended in failure.

LIMES.

Except in hotels and restaurants, limes are scarcely known. They are as a rule imported through New York dealers. In New York the consumption of limes is increasing rapidly. (I have submitted a full report on the fresh lime trade there a copy of which will be found annexed.) At Toronto, I found that limes were used in hotels and restaurants, but not to any extent. In discussing the question with one large wholesale fruiterer I was informed that lemons keep better than limes, and that from a business point of view the former were preferred. The superiority of limes over lemons was not questioned Better transportation facilities, direct with the West Indies, would no doubt allow of limes being placed on the market in better condition than is now possible, and at a cheaper rate. Undoubtedly, unsatisfactory steamship facilities have been a great drawback to the trade, not only in limes, but in other fruit. At the time of my visit, as much as 5c. was paid for a lime. I endeavoured to interest one or two of the large wholesale fruiterers, and the large department stores in this fruit, but, under present conditions, I hardly think they will find it worth while to take up the matter. Neither the wholesale nor retail men can be expected to push limes against lemons, when it is admitted that lemons pay them better; whereas, a fruit association could advertise the fruit and place consignments with dealers. A small loss might be incurred in starting the business, but this would be more than recovered, as the trade developed. At Montreal, and also at St. John, N.B., I found that a similar state of affairs existed.

In regard to selecting and packing limes for the Canadian market, I cannot do better than recommend growers to follow closely the lines laid down in the annexed report on British West Indian limes in New York.

LIME JUICE.

In the cities visited I saw large coloured posters advertising 'Montserrat' lime juice. These advertisements were very effective, and I was informed by a representative of the National Drug Company, who are the Canadian agents for the lime juice, that the demand was increasing. The chief drawback of the beverage was its musty after-taste. If this can be eliminated, it is likely to become much more popular than it is to-day. In Toronto I had enquiries for the names of exporters of raw lime juice. These I readily gave. One firm told me that they could handle 3,000-4,000 gallons per annum. So far they had found it difficult to clarify. Provided they could overcome this difficulty, their output could be easily doubled. The outlook for prepared lime juice of good quality appeared favourable.

GREEN LIMES.

Two firms, which make preserves on a large scale, asked for the names of exporters of green limes; what they wanted were limes about half grown. I do not know if it would pay growers to pick and ship immature limes. Still, the enquiry was made, and it might be possible to extend trade in this direction.

CACAO.

This is a product which enters Canada free of duty. West Indian raw cacao has therefore to meet the produce of foreign countries on equal terms. The consumption of cacao and chocolate is increasing rapidly. The largest manufacturer in Canada informed me that, although he would prefer to buy West Indian cacao only, if he could get it of the desired quality, he had at the present time to buy other cacaos for certain classes of goods. From the manufacturer's point of view, in whatever line, it is necessarily a question of dollars and cents; if you can supply what he wants at about the same price, he will buy. From Imperial considerations he may perhaps give you a slightly higher price for produce of equal quality to that of foreign, but naturally will not risk his profits in doing it. I was informed in Toronto that West Indian grades of cacao had shown considerable improvement in recent years. This improvement was especially noticeable in imports from Trinidad, Grenada, and Jamaica, and large lots could be bought to sample. This is what buyers like. They do not care to handle small lots, which although coming from the same estate, may vary from year to year. They pointed out that firms in Trinidad bought cacao and graded it carefully, so that buyers could always depend on getting what they wanted in quantity, and of a certain grade. The produce of small growers is therefore handicapped to a considerable extent. Perhaps a system of co-operative grading and selling of the small lots of cacao grown in some of the islands could be instituted. It would appear from what I learnt in Canada that if this was done the produce would sell much better.

ARROWROOT.

I was directed to make special enquiry in regard to this product. Arrowroot, as is well known, is one of the chief products of St. Vincent. For some years the industry has been in a depressed condition, owing to low prices. Recently an effort has been made to put it on a better footing by the formation of an Arrowroot Growers' and Exporters' Association. An Ordinance has also been enacted by the Government which provides for the collection of an export cess of 6*d.* per barrel of arrowroot, and the money so collected is to be used solely for the purpose of advertising the product in countries where it is not used to any extent.

I saw several importers at Toronto and Montreal, and they all informed me that at the present time only small quantities used by the grocery and drug trades. I found that they imported the arrowroot chiefly from the United Kingdom, packed in 7-℔. tins, the wholesale price being 5c. per ℔. I pointed out that it would probably pay them better to import it direct from St. Vincent, or through Canadian representatives of local firms, as it was undoubtedly St. Vincent arrowroot that they got from England. In this connexion, a representative of the West India Company of Montreal informed me, that after a considerable amount of trouble, his firm had succeeded in getting arrowroot put up in Canada in small packets for the grocery trade, and that the business was increasing slowly. I interviewed the editor of the *Canadian Grocer*, a well-known Canadian trade paper, and he thought that an advertising campaign was likely to assist considerably in making the product known. Of course, arrowroot has to compete with corn starch in the household, and unfortunately for St. Vincent, the latter has practically superseded it.

What is required is a thorough investigation of the properties of arrowroot from a chemical and physiological standpoint. It is all very well to state that arrowroot is better than other starches for certain purposes because it makes a stronger and more translucent paste; and as a food is more easily digested, etc.; but as far as I am aware, its properties have not been fully worked out scientifically, and the results put on record in an authoritative manner.

In the matter of cereal starches, such as rice, wheat and maize, a good deal of work has been done, but root starches appear to have been somewhat neglected. Obviously, if arrowroot growers had a number of facts based on scientific observations, and results which they could use when endeavouring to find new markets, or to extend the trade in old ones by means of advertisements, such advertisements could be made to carry a great deal more weight.

During my visit to Toronto, I had two interviews with Dr. Kaufmann, whose scientific work in connexion with starches is well known. Dr. Kaufmann informed me that he would be quite willing to undertake an investigation of arrowroot and other root starches, and to test the results obtained on a commercial scale. He is at present connected with one of the largest starch manufacturing firms in Canada, and has many opportunities for carrying on investigations, under the most suitable conditions. The matter appeared to me to be so important that I promised, with the permission of the Imperial Commissioner, to send him, as soon as possible after my return to the West Indies, large samples (50-100 ℔) of arrowroot, cassava, yam, and sweet potato starches, in order that he might make preliminary observations on them.

Of course, in the United Kingdom, arrowroot is largely used as a raw material; e.g., as a 'filler' for cacao powders. The cacao manufacturers whom I saw told me that at the present time, Canada was so prosperous that they had not found it necessary to make a cheap grade of cacao powder. I pointed out that possibly they would have to face the question sooner or later, as there was likely to be competition from outside sources. I ascertained, however, that a small quantity (about 50 bags) of Singapore tapioca flour (cassava starch) was used annually by the largest cacao firm. I suggested that arrowroot would be better, and mentioned that British cacao manufacturers preferred it. Before I left Canada, I understood that an experimental trial would be made.

Arrowroot was generally considered to be too expensive a starch to handle. For the information of exporters I might mention that corn starch used for moulds, and Singapore tapioca flour used as a 'filler' costs from 3c. to 3¾c. per ℔., laid down. Should arrowroot be allowed to enter Canada free of duty, as is suggested by the Royal Commission in their report, it will certainly have a much better chance of being taken up by manufacturers and others.

CASSAVA STARCH.

I had several enquiries for this starch. It is imported chiefly from Singapore. There was a good demand for it by cloth manufacturers, at 3c. to 3¾c. per ℔. Could the product be placed on the market at about 3c. per ℔., in large quantities, it could also be used for making glucose syrups. For the latter purpose it is possible that lower grades than those usually made in the West Indies would be suitable.

At the present time there is an import duty of 75c. per 100 ℔. For glucose purposes it may be found that a cassava meal would answer. This would mean that, in the process of manufacture, the coarser fibres only would be eliminated. A product such as this might be allowed entry free of duty, as a raw or unmanufactured material. I would suggest that experiments in the manufacture of cassava meal be made in the West Indies, the idea, of course being to produce a satisfactory article at as low a cost as possible.

In speaking to Dr. Kaufmann on the possibility of shipping dessicated air-dried cassava roots, he thought it would not be worth while, from a business point of view, for the cellulose the roots contained would not be wanted; there were plenty of cheap cellulose substances always available.

SPICES.

I did not have an opportunity of going very fully into the question of the market for spices. I had one or two enquiries for green ginger and kola nuts, and the information desired was given. It would be worth while for growers of ginger to get in communication with Canadian manufacturers of preserves.

COTTON.

In regard to cotton, I understood that only the short staple kinds were at present being spun, and as yet there was no demand for the long stapled Sea Island produced in the islands. I was unable to visit any of the mills, to get first-hand information.

BROOM CORN.

A small exhibit at the Toronto Exhibition drew the attention of two broom manufacturers, and I was asked to give the names and addresses of growers. Good prices were being paid for broom corn. The sample shown—I believe by Antigua—was considered to be of good quality. I was asked for a quotation for a car-load—70 bales of 300 lb. each—which, of course, I could not supply. There is a good demand for the product. The somewhat extensive trials being made in Antigua and Montserrat should soon indicate whether it can be produced at a profit, on a fairly large scale.

SUGAR.

There appeared to be a demand for centrifugalled muscovado sugar of good quality. Enquiries were made by grocery brokers, and others. This sugar was used by grocers and biscuit manufacturers; and in the wine trade. Ordinary muscovado did not appear to be wanted. One large sugar broker at Montreal informed me that the last season's business in this class of sugar had been very poor, and it had been very difficult to obtain prices in a satisfactory ratio to the value of 96° crystals.

At Montreal I had an interview with a representative of the Company controlling the new McMullen process for dealing with sugar cane, and also with Mr. H. D. McMullen, a son of the inventor. Both spoke very enthusiastically of the process. They informed me that the experimental trials made on a large scale during the past season in Cuba had been successful, and that the United Fruit Company, who had a large interest in the patents, had placed orders for machinery for work in connexion with their central sugar factories in Cuba. Details of the invention have been published in the *International Sugar Journal* and other technical papers.

From what I could learn, efforts were being made to work with the manufacturing and refining branches of the sugar trade, so as to avoid upsetting existing interests.

The question as to whether desiccated, that is, shredded and dried canes containing sugar would be allowed entry into Canada free of duty as a raw material, is a matter which will no doubt be considered by the proper authorities when the time for action arrives. Besides, a good deal also depends on the question as to whether it will be found good business to shred and dry the cane at the place where it is grown, ship the material so obtained, and then extract the sugar by diffusion. On the face of it, the cost of evaporating the moisture from the shredded cane and subsequent handling of the material to obtain the sugar and cellulose appears to be the factor which might limit any extensive utilization of the process in this particular direction. It was suggested that, in the interest of sugar growers in the West Indian colonies, the new process should be thoroughly investigated on the spot by a Special Commissioner—one who is fully conversant with the details of the manufacture of sugar. This suggestion appears worthy of consideration.

MOLASSES AND SYRUP.

At Toronto and Montreal, there was a demand for low grade molasses. At Toronto, I had enquires for this product by a firm interested in the manufacture of stock feeds. At Montreal, I inspected a shipment of Trinidad molasses which had leaked badly on the on the voyage. In some cases, the puncheons were half empty. The stowage on board the steamer was satisfactory. On examining the packages it was evident that they had not been been properly 'trimmed' before being shipped. A shipment of Barbados molasses by the same steamer arrived in excellent order. In the interest of exporters, I have thought it wise to refer to this matter here.

One sugar-broker, also at Montreal, told me that during the past season too large a quantity of West Indian 'fancy molasses' or syrup had been sent there. At St. John, N.B., however, I was informed that the outlook of the trade in this product was good, and that the demand was increasing.

PRESERVES.

There was a considerable amount of interest taken in exhibits of guava jelly in bottles at the Toronto and St. John Exhibitions. Manufacturers of preserves, did not think that there would be much demand for the jelly unless exporters were prepared to put it up in tins holding about 28 lb. each. For this purpose it would have to be made of a somewhat thinner consistency than that usually sent to Canada in bottles, so as to allow the manufacturer to 'melt it down' and bottle it.

From what I could gather, there was scarcely any opening for other classes of preserves.

I should have liked to have made more thorough enquiry into the possibility of increasing trade in West Indian products generally, but as has been mentioned before, my time was very limited, and I could not do so. I trust, however, that the information given in this report will be found of some interest and value.

Every assistance was most willingly given me by the Secretaries of the different Boards of Trade; Mr. Richard Grigg, His Majesty's Trade Commissioner, Montreal; The West India Company, Montreal; Mr. J. D. Allen, Toronto; Mr. H. B. Scholfield, St. John, and many others, in carrying out the mission entrusted to me.

Mr. C. S. Pickford was very helpful at all times, and my best thanks are due to him for his efforts on my behalf.

I left St. John, N.B., for the West Indies, via New York, on September 14, and arrived at Barbados on October 4.

I have, etc.,

(Sgd.) W. N. SANDS,

Agricultural Superintendent.

The Imperial Commissioner of Agriculture
for the West Indies,

Barbados.

BRITISH WEST INDIAN LIMES IN THE NEW YORK MARKET.

BY W. N. SANDS,
Agricultural Superintendent, St. Vincent.

During the time that the writer was visiting the recent exhibitions in Canada, as the representative of the Imperial Department of Agriculture for the West Indies, an opportunity was taken, on the suggestion of the Imperial Commissioner of Agriculture, to ascertain the condition of the New York market in regard to West Indian limes. The special points in relation to which investigations were made included: (1) the general nature of the New York trade in British West Indian limes; (2) the probability of interference in the business by supplies from Porto Rico, Florida, Cuba and Mexico; and (3) the question as to whether the supplies now coming from the British West Indies are of the quality required for the market, and properly packed, or whether alterations and improvements in these matters are desirable.

In the course of the investigations, six firms were visited. These were chosen particularly because they are most intimately connected with the West Indian lime trade, on account of consignments to them, or the purchase by them, of the fruit. An enquiry into the question of suitable shipping facilities was initiated, because the writer had been informed that fully 20 per cent. of the limes in certain shipments were rotten, on arrival at New York. The chief causes instanced for this were (a) the length of the voyage, and (b) unsuitable storage on board the steamers; although it was admitted in this case that there was a possibility that, sometimes, the fruit was not properly selected and packed. In regard to these matters, the agents of the Quebec Steamship Company, by whom the fruit has been most generally carried in the past, admitted that occasional delays had taken place at St. Croix, and that when this was the case the limes shipped arrived in poor condition. They had, however, arranged for Dominica—the island shipping the largest quantity of fruit—to be made the last port of call. They also gave an assurance that, even if it was found necessary for the vessels to call at islands farther north, the stay at each would be only of very short duration. It was stated, in regard to storage accommodation, that limes travelled fairly well, unless they were stowed near boilers; care had been taken to avoid such stowage. It was advised by the same firm that, if the limes were packed in half-barrels, instead of in full-sized barrels, they would reach the market in better condition. It was not recommended that this fruit should be packed and shipped in cases, after the manner of oranges and other fruit, even though this admits of closer stowage. The reason is that such packages are only suitable for limes where there is cool storage.

Messrs. Gillespie Bros., General Commission Agents and Brokers, were next consulted, in regard to matters connected with the fruit on the market. This firm usually sells the limes to one or another of the large wholesale houses; but when the market is glutted, it is found necessary to dispose of the fruit by auction. The statement was made that the consumption of limes in the United States is increasing, the fruit being mostly in demand in the warmer months of the year. Most of it is sold to hotels and restaurants, for use in making alcoholic drinks. It occurred to the writer, in connexion with this matter, that the spread of temperance in the United States might possibly affect the trade in the future. This was admitted, but it was thought that the day when this would happen was yet far distant. Lime juice is hardly known in New York, though there appears to be an opening for this product, provided of course that it received extensive and effective advertising. Curiously enough, it is most generally associated there with the consumption of alcohol, and the prejudice against it on the part of some persons, on this account, would have to be overcome.

Another firm which receives limes on consignment is Messrs. Middleton & Co., General Commission Agents and Brokers. Here, it was stated that buyers had often complained of the lack of grading that obtains in regard to West Indian limes. The demand on the part of the fruit dealers was for sound, thin-skinned, clean and bright limes, of medium size. The chief complaints were made in regard to the smallness of some of the limes shipped, the largeness of others, the coarseness of the rind, and discoloration by dirt, black blight and scale insects. The statement was made that it was almost impossible to sell limes of such inferior character. It was advised that the best season to ship was about March and April, when it had often been difficult to supply the demand for limes. In July and August, on the contrary, it frequently happened that the market was glutted by the receipt of excessive quantities of the fruit; so that only moderate shipments should be made during these months.

Among the wholesale buyers, Messrs. McCormick, Hubbs & Co. recommended the continuation of shipment in barrels; these, however, should be of a standard size. The barrel favoured by this firm is made in the West Indies, apparently in Dominica, from imported shooks. Such a package has a clean and neat appearance, in strong contrast to that of the dirty-looking flour barrels of various sizes, in which limes are frequently shipped from the West Indies: and there is the additional consideration of the favourable effect which a neat, clean package of standard size makes on the prospective buyer. When the writer was visiting this firm, a shipment of Dominica limes, in barrels of the kind mentioned, had recently come to hand. On inspection, it was seen that the barrels, as a rule, were provided with four perpendicular lines of three holes each, for ventilation; it was suggested that six holes in the row would serve the purpose better. Shrinkage of the fruit had caused a large space to be left inside the barrels; this admitted of bruising when the packages were handled. It was stated that this consignment had arrived in better condition than usual, only a small percentage being unsound. The separate fruits were placed in brown wrapping paper, and Messrs. McCromick advised, in regard to packing, that the limes should be wrapped in this, previous to being placed closely in barrels, in definite layers, and pressed tightly; it was thought that the best method would be to press each half-dozen layers, or so, as they were being packed. Brown paper was superior to rice paper or tissue paper, partly because it absorbed the products of decay to a certain extent. This firm, like the others, laid particular stress on the desirability of the limes being properly graded before shipment. In illustration of this method, it was pointed out that unwillingness to handle the limes that had been sent from Porto Rico, Cuba, Florida and Mexico had been the outcome of the poor quality of the fruit.

The firm which gave the information that has just been presented assorts and repacks the limes, on their receipt, some being sent out in barrels and others in boxes. The fruits are re-wrapped, when necessary, with brown wrapping paper, and carefully placed in packages of the kind mentioned. In either case, the limes are well shaken together, and pressed, in order to prevent damage, during transportation to different parts of the United States. The size of the boxes is 10 inches by 6½ inches by 6½ inches—one which allows of their being readily placed under the bar counter in hotels and restaurants. Each of these is made with slatted sides, and holds 100 assorted limes.

On the question of carriage of the fruit to the West Indies, this firm was of the opinion that the steamers in which they have to travel were unsuited to their transport, and that the arrival of certain shipments in poor condition was largely attributable to this cause.

Corroboration of all these facts was received from Messrs. Arthur Courtin & Co., who are also large buyers of limes. This firm was of the opinion, also, that the chief drawback to the New York trade in West Indian limes was the unsatisfactory kind of steamer in which they are carried. Like Messrs. McCormick, they prefer the Dominica lime to any other, chiefly because it possesses the necessary acidity and aroma, combined with an attractive appearance. The acidity of the fruit is of particular importance because, when references were being made to the quality of certain shipments of limes from Cuba, it was stated that the fruit was 'sweet', and therefore not wanted. Messrs. Courtin do not find it worth while to handle limes from Cuba, Porto Rico, or Florida. The objection to the Porto Rico product is its inferior quality; it is most often used in the street trade. Good limes were sometimes received from Florida, but only during a very short season. Similar information to that which has been given was supplied by Messrs. F. S. Maynard & Sons, another wholesale firm, which handles a large quantity of limes each season, but which, unlike Messrs. McCormick, does not find it necessary to assort and re-pack in barrels; it has, however, a trade with hotels and restaurants in small boxes of limes like those just described. No recommendations, besides those given already, were made by this firm.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS.

(1) The consumption of fresh limes is increasing rapidly in New York, and British West Indian limes—more particularly those from Dominica—control the market.

(2) There is little fear of competition, at the present time, from Porto Rico, Florida, Cuba, and Mexico.

(3) The shipments from the British West Indies are not always satisfactory; though those from Dominica show superiority in this matter, with room for improvement.

(4) The poor condition, on arrival, of shipments from time to time, has been due in no small measure to the effects of the lengthy voyage, in steamers not possessing suitable storage accommodation. Efforts should be made to get the fruit to New York as quickly as possible; these already exist in the case of Dominica.

(5) In order to obtain the best results, growers and shippers must give close attention to the following matters: (a) the fruit should be carefully picked, cured and graded, so that only perfectly sound and clean limes will be shipped; (b) limes discoloured with earth, scale insects, or black blight should be sponged or brushed, after the fruits have been cured for a day or two, care being taken not to injure the skin in any way; (c) the fruit should be allowed to dry thoroughly, after being cleansed, and then be wrapped in brown wrapping paper; (d) in selecting the fruit it would appear that a lime measuring from 1¾ to 1⅞ inches in diameter is the size desired by buyers: grading to this size should be adopted; (e) the fruit should be packed closely, in layers, in well-ventilated barrels of standard size.

It is the opinion of the writer that, if growers and shippers select, grade and pack their limes according to the methods that have been described, and keep in close touch with the requirements of buyers, there is no reason why British West Indian limes should not continue to control the New York market, and realize remunerative prices.

(Pages 73 to 156 issued January 11, 1911.)

FUNGUS DISEASES OF GROUND NUTS IN THE WEST INDIES.

BY F. W. SOUTH, B.A. (Cantab.),

Mycologist on the Staff of the Imperial Department of Agriculture for the West Indies.

Three fungi are found on ground nuts in the West Indies—two attacking the leaves, and one the roots, pods and surfaces of the nuts. The leaf fungi are *Uredo arachidis*, Lagh., and *Cercospora personata*, Ellis. The root fungus is unidentified.

UREDO ARACHIDIS. This fungus is, according to H. and P. Sydou (*Annales Mycologici*, Vol. VI, p. 136), identical with *Uromyces arachidis*, though Massee (*Diseases of Cultivated Plants*, p. 566) states that it is not known if there is any genetic connexion between the two. The fungus forms minute scattered or crowded yellow pustules, or sori, on the under surface of the leaf. It occurs to some extent on local varieties of the ground nut, but is more destructive on imported plants. It was reported from St. Vincent in 1907 on the Dixie Giant variety. It attacked all the imported varieties in Dominica in 1909 and 1910 (see p. 161) and also occurred in Montserrat in 1907, 1909 and 1910. It was reported from St. Kitts in 1910. In Montserrat, Mr. Robson, the Curator of the Botanic Station, is of the opinion that it shortens the life of the plant and causes shrinkage of the nuts. In Dominica, however, experiments on the number and weight of the nuts produced by healthy and unhealthy plants in 1910 showed that the fungus had no appreciable effect. (See p. 168). It only appears, as a rule, after the vines have almost completed their growth, and in some cases is confined to the older leaves. Spraying with Bordeaux mixture is said to have been effective in checking its spread in St. Kitts and in Montserrat, in 1910: but in Dominica, neither Bordeaux mixture nor a mixture of equal parts of lime and sulphur has been found to produce much effect. In connexion with the treatment of ground nuts with a mixture of powdered lime and flowers of sulphur, Mr. A. J. Brooks furnishes the following interesting note from Dominica. A light dressing of the mixture is dusted on to the upper surface of the leaves from muslin bags. This is done just before sunset. At sunset the leaves fold up, and by so doing prevent the removal of the fungicide by wind. At the same time, the under surfaces of the leaves are exposed. Another dressing is given an hour after sunset, when the under surfaces of the leaves are treated. The light film of dew which will have fallen during the hour which has elapsed assists the mixture to adhere. In those islands where the disease is believed to cause damage, spraying with Bordeaux mixture appears to be effective, and should be continued. An ammoniacal solution of copper carbonate might also be used experimentally.

The fungus is not known to possess any other spore form than the uredospore. P. and H. Sydou (loc. cit.) state that the teleutospores of *Uromyces arachidis*, described by P. Hennings, are in reality only uredospores. A search has been made in Dominica for the same fungus, on other host plants in the neighbourhood of the plots on which the ground nuts were growing. The same stage and an aecidial stage were looked for, but neither was found. The fact that this disease appeared on plants grown from disinfected seed, together with the sporadic nature of its appearance on the plots, in the island referred to, renders it probable that some other host plant exists; but if it does, it has not yet been found. (See p. 168.) Since the fungus first appeared in 1910, on plants grown from disinfected nuts, and since these nuts, though themselves attacked by the root disease fungus produced plants entirely free from root disease, it seems unlikely that spores of the fungus are carried on the nuts. There is, however, a possibility that a resting mycelium may occur inside the nuts. This point requires investigation.

Diagnosis: Sori small, scattered, on the under side, surrounded by the ruptured epidermis, brown; uredospore ovoid-round, minutely echinulate, 24-30 *Micron* diam.; epispore yellow.

CERCOSPORA PERSONATA. This fungus forms brown or olive-green, almost circular spots on the under surface of the leaves, varying from 2 to 4 mm. in diameter. It occurs on ground nuts in the United States, and attacked the imported varieties in Dominica in 1909. It is also reported to have occurred in Barbados in 1910. This suggests the possibility that it may have been introduced on the seed. The vigour of its attack in Dominica was probably due in part to excessive moisture, as the season was wet.

Bordeaux mixture was found to have but little effect in controlling it; neither was lime-sulphur mixture completely successful. Bancroft (*A Handbook of the Fungus Diseases of West Indian Plants*, p. 55) recommends an ammoniacal solution of copper carbonate. Good drainage is also effective in assisting in its control.

The fungus was first described by Berkeley and Curtis as *Cladosporium personatum*, and a variety of it was found by Berkeley on *Cassia occidentalis*. (*Journal of Mycology*, Vol. VI, p. 68.) This plant is a common weed in several of the islands. Ellis found it on ground nuts in America in 1885, and identified it correctly as a Cercospora.

Diagnosis: Forming small, brown, orbicular spots (2-4 mm.) on the lower surface of the leaves. Hyphae densely tufted, short, brown, sparingly septate. Conidia mostly clavate, pale brown, 1-3 septate, 30-50 × 5-6 *Microns.*

ROOT DISEASE. In 1908, the Spanish and Tennessee Red varieties in St. Kitts were attacked by a root disease. This appeared on all the varieties in Dominica in 1909, and on the Spanish in Grenada in the same year. This variety was also attacked in Grenada in 1910, and slightly affected in Nevis in the same year.

Plants attacked wilt rapidly, and in two days from the first wilting of the leaves, are seen to be completely dead. The fungus kills the roots, and then spreads to the collar and the base of the stems. The pods also are affected and the mycelium spreads to the surface of the nuts. It causes the latter to shrink and lose colour to such an extent that over 40 per cent. of the crop in Dominica in 1909 was lost, owing to this shrinkage, alone. Weighings of ten healthy and ten diseased nuts showed that the latter were 40 per cent. lighter than the former. Although the fungus occurs on the surface of the nuts, it does not appear to penetrate them, since diseased nuts disinfected with corrosive sublimate solution will produce healthy plants.

The fungus has been found on Aroids, Antirrhinums, and some Compositae in Barbados, in addition to ground nuts: on egg plants, tomatos, and seedling lime trees in Dominica; and on alfalfa in Antigua. It would, therefore, appear to be a fairly general root parasite, and one of considerable importance.

The causative fungus has a mycelium which, in its young condition, forms a cobweb-like covering over the diseased portions. The hyphae are colourless and provided with occasional clamp connexions. As they grow older, they tend to form narrow yellow to brown filaments which arise in a characteristic way. The original hypha gives off lateral branches, two or more at the same point. These branches run along parallel, and closely adpressed to the original hypha. They may in turn give off branches arising at the same point, this being usually also near the point of origin of the primary branch. The branching is somewhat similar to that characteristic of the Rhodophyceae. In this way a filament is formed. Occasionally, the place of one of the branches, arising at any given point, is occupied by a prominent clamp connexion. The brown colour of the older parts of the mycelium is due to some deposit on the cell walls, but the yellow colour is caused by the presence of numerous small rod-shaped yellow crystals, on the outside of the hyphae. The fungus does not appear to form fructifications easily, as none have so far been found. Numerous small brown sclerotia about 1 mm. in diameter and approximately spherical in shape are, however, of frequent occurrence. These arise as minute tufts of colourless hyphae, which become compact and smooth externally, turning yellow and finally brown, as they do so. In section, they show an outer covering of brown cells two or three cells deep, and an inner colourless mass of loosely woven pseudoparenchyma. Taken altogether, the appearance of the fungus is very characteristic.

When a piece of land has become infected with this fungus, the safest course is to dress it with lime and allow it to lie fallow for several months after the crop has been removed. This treatment applies to any crop. In the case of ground nuts, subsequent crops should be planted in a different place, and if possible, healthy seed only should be used. If it is necessary to employ infected nuts for planting, these should be immersed for five minutes in a solution of corrosive sublimate, of a strength of 1 part in 1,000 of water. Drainage appears to have but little effect on the spread of the disease, according to observations in Barbados and Grenada. Lime seems to be without effect in checking its spread. But it is probable that where this is applicable, trenching the diseased area in the usual way would prove of service in this respect.

SUMMARY.

Three diseases of ground nuts have been observed in the West Indies :—

(1) A rust fungus, *Uredo arachidis.* This is of very general distribution, both on imported and local varieties throughout all the islands. The amount of damage which it is capable of causing appears to vary in different islands, as does the success of the control measures employed.

(2) A leaf spot fungus, *Cercospora personata.* This has been observed at present in Dominica and Barbados only, and is not of a serious nature.

(3) A root disease, unidentified. This occurs in Barbados, Grenada, Dominica, St. Kitts and Nevis. Its host plants are numerous and of a very general nature. It is an important fungus, difficult to control.

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NOTES ON GROUND NUTS IN THE WEST INDIES

The following paper is intended as a summary of the results that have been obtained up to the present in the experiments on the cultivation of imported varieties of ground nuts. These have been conducted at various Botanic and Experiment Stations in the West Indian islands during the last few years. An account of them is given in the Annual Reports of the Botanic Stations from the year 1907 onwards. In addition to the results thus obtained, various points in connexion with these plants have also been included, in order to make the information presented as complete as possible. An earlier paper on this plant, by Freeman, containing a summary of the position of the industry in the West Indian islands before the introduction of the new varieties will be found in the *West Indian Bulletin*, Vol. IV, p. 101. Various articles have also appeared on this subject in the *Agricultural News*; references to these are given at the end of this paper.

In the year 1907-8, two American varieties of ground nuts, Dixie Giant and Tennessee Red, were imported by the Imperial Commissioner of Agriculture, and distributed for trial at the Botanic and Experiment Stations in St. Vincent, St. Lucia, Dominica, Montserrat, Antigua and St. Kitts-Nevis. In the subsequent year, two other varieties, Spanish and Carolina Running, were imported from the United States and grown in the same islands. The results obtained were, on the whole, disappointing, with the exception of the yields given by the varieties grown in Dominica. This was to some extent due to poor germination, in the case of the Dixie Giant variety, and in that of the other varieties, to the attacks of fungi. These consisted of a rust fungus on the leaves, reported as *Uromyces* sp. and *Uredo* sp., and a sterile root fungus which has since been found on several host plants, but has not so far been known to form any kind of fructification. (See preceding article.)

In the year 1909, the trials were continued, some varieties being rejected in certain of the islands. In Dominica, the results were largely spoiled by the outbreak of three different diseases on the experiment plots. Two fungi occurred on the leaves—the rust fungus referred to above and identified at Kew as *Uredo arachidis*, Lagh., and a leaf spot fungus, *Cercospora personata*, Ellis. The same root disease fungus also attacked the roots, lower portions of the stem, pods and surfaces of the nuts. The rust fungus also occurred in certain of the other islands in that year. The results obtained throughout the islands were, however, considerably more promising than those of the two previous years.

DESCRIPTION OF THE VARIETIES.

A short account of some of the American varieties is given in *Farmers' Bulletin* No. 356, of the United States Department of Agriculture. Descriptions of others have been obtained from local sources.

Spanish.—This variety is a strong-growing plant with upright stems and thick foliage. The pods are small, and are clustered about the base of the plant: they are rough, and dark in colour, and each usually contains two nuts which entirely fill it. The pods adhere well to the plant when it is dug up, and are thus easily reaped. The nuts are light brown in colour and rich in oil. The period from the time of planting to maturity varies in the West Indies from twelve to eighteen weeks.

Carolina Running.—This variety has long trailing stems and thick foliage, which render it suitable for a green dressing. The pods are borne on the long trailing stems, and do not adhere well when the plant is dug. Each contains two nuts, on an average, which are about three times as large as those of the Spanish variety. The period from the time of planting to maturity is from sixteen to eighteen weeks, in the West Indies.

Tennessee Red.—This variety is similar in habit to the Spanish, but the pods are longer, though small, and contain four, sometimes five or six, nuts of a dull red colour, crowded together. It is more suitable for stock-feeding than for market purposes. The period from planting to maturity varies from twelve to eighteen weeks.

Dixie Giant.—This variety is so called owing to the large size of its pods, while the nuts are about four times as large as those of the Spanish. It was found that it did not mature well in the United States, and this experience has been repeated in the West Indies.

The plants are trailing in habit, and the foliage is thin. The pods are borne along the trailing stems, but adhere well on digging. Each pod contains two large nuts, of a very light reddish-brown colour. The plants require from seventeen to twenty-four weeks to mature.

Virginia Bunch.—This is a somewhat dwarf plant with upright stems and rather light foliage. The pods are large and clustered about the base of the plant, and adhere well on digging; they are bright and clean, and contain two, or sometimes three nuts in each. The nuts are light brown in colour. The plants take fifteen weeks to mature, in Dominica.

Virginia Runner.—This is a strong-growing variety with creeping stems and heavy foliage. The pods are scattered along the stems and do not adhere well on digging. In other respects it resembles the Virginia Bunch variety.

African.—This variety is also of a trailing habit, with dense foliage. The pods are borne along the stems and do not adhere well on digging. Each pod contains three nuts, of a light brown colour. These plants required twenty-four weeks to come to maturity in Dominica.

Gambia.- This variety is of a trailing habit, with dense, compact foliage. The pods are scattered along the stems, and adhere particularly well on digging. Two nuts are produced in each pod. These are of a light pinkish-brown colour.

A strain having three nuts to the pod was found to occur occasionally in Montserrat. This has since been found to breed true.

PREPARATION OF THE LAND, PLANTING AND HARVESTING.

The soil most suitable to this crop is a sandy loam containing a sufficient supply of humus. It should be well drained, free from weeds and in a good state of tilth, especially on the surface. It is not advisable to use farmyard manure on the land in the same year as the nuts are to be planted, as by this means a large number of the seeds of weeds are introduced ; this manure also causes the nuts to form large quantities of foliage and a high percentage of poorly filled pods. A green dressing may, however, be grown and turned in, some few months before planting. It is probable that a moderate dressing of lime, at the rate of 1,000 to 2,000 ℔. of freshly burnt lime to the acre, would prove advantageous on all soils except those containing an excess of this substance.

In the West Indies, the seed is planted in rows 1½ to 2 feet apart, and the plants are from 1 to 1½ feet apart in the rows. The greater distances apply to the trailing varieties. The nuts are shelled, and one or two are planted in each hole.

The plot should be kept free from weeds, but should not be disturbed after the nuts are beginning to form.

When the nuts are ripe, the plants are dug up and the pods removed by hand. They are then dried in the sun and stored in sacks or bags.

A thresher for removing the nuts in their shells from the vines is made at the Ellis Keystone Agricultural Works, Pottstown, Pa. ; the General Southern Agent is Mr. G. C. Burgess of Petersburg, Va., from whom full information can be obtained. It is probable that other machines are also to be obtained, but this is the only one concerning which information has reached this office at present. (See *Agricultural News*, Vol. X., p. 41.)

RESULTS OF THE TRIALS FOR THREE YEARS.

The results obtained in 1907 were of a very preliminary nature, as the area planted was very small in each case. In consequence, little could be done beyond observing how the plants germinated and grew, and obtaining as much seed as possible for planting in 1908. A few points of interest are, however, worthy of record.

In St. Vincent, the Tennessee Red variety germinated very badly and practically no nuts were obtained from it. The Dixie Giant plants were attacked by a rust fungus identified then as *Uromyces* sp. It is, however, almost certainly the same as *Uredo arachidis*.

In St. Lucia, the Dixie Giant variety, which was the only one grown, yielded nuts which were found to germinate in the ground before they were properly ripe. This indicated the necessity for planting in that island at such a time as should allow the nuts to ripen after the end of the wet season.

In Dominica, the two American varieties made a good start and gave a satisfactory yield of cured nuts. It may also be noted that the 'African' variety which was grown in a larger plot of $\frac{1}{8}$-acre gave a yield of 443 lb. of cured nuts, or an estimated yield of 3,569 lb. of cured nuts per acre.

In Montserrat, the results obtained were not very promising: the nuts produced by the Dixie Giant variety were considerably shrivelled.

In Antigua, the foliage of both imported varieties was attacked by caterpillars. These were kept in check by the use of a mixture of Paris green and lime in the proportion of 1 to 6. The soil of the plot was heavy, and did not appear very suitable to the plants.

In St. Kitts, the Dixie Giant variety grew well until October, when heavy rains fell, just as the young nuts were forming. The rain caused renewed growth and this resulted in the loss of many of the nuts.

In Nevis, the plants of both varieties dried off. This suggests the probability that they were attacked by a root disease.

The results of the trials conducted in 1908 and 1909 are summarized in the following table :--

IELD PER ACRE OF CURED NUTS.

Where grown	Variety.	Yield in pounds. 1908.	1909.		Remarks
		Limed.		Unlimed.	
St. Lucia ...	Carolina Running	504			
	Spanish	no			
	Dixie Giant ..	crop			
	Tennessee Red .	obtained			
Dominica..	Carolina Running	1,137		757	In 1909 all the plots were attacked by diseases.
	Spanish	1,940		613	
	Dixie Giant ...	335		535	In 1909 part of crop was stolen.
	Tennessee Red ...	459		370	
Montserrat	Carolina Running	889	2,740	2,320	
	Spanish	364	1,440	1,320	
	Dixie Giant ...	failed to grow			
	Tennessee Red .	400			
	Gambia ..		2,430	1,740	
	Local variety .	..	320	286	
Antigua ...	Carolina Running	680			
	Spanish ..	440	320	400	Soil is apparently unsuitable.
	Tennessee Red ...	400			
	Dixie Giant ...	960		...	Imported seed failed to grow in 1908
St. Kitts ..	Carolina Running	1,360	2,215	1,735	
	Spanish	300	3,090	3,307	Root disease, 1908.
	Dixie Giant ...	...	..	..	In 1908 the nuts rotted in the ground.
	Tennessee Red ...	300	3,170	3,200	Root disease, 1908.
	Local variety ...	1,800	1,470	1,200	
Nevis ...	Carolina Running	1,400	2,667	1,813	
	Spanish	810	3,200	747	
	Dixie Giant ...	120	...	...	1908. The nuts rotted before ripening.
	Tennessee Red ...	360			
	Local variety ...	570			

On the whole, the Carolina Running and Spanish varieties have done best. Of the two, the Spanish is the more likely to be popular as it is a bushy erect plant, and consequently easy to reap, while it ripens in from three to four months. The nuts are small; this is a further advantage, as they are frequently sold by measure and not by weight. This variety is however, very susceptible to root disease. The Carolina Running variety has a trailing habit, and the crop is more expensive and troublesome to reap than that of the Spanish. This habit would, however, be an advantage if the plant were used as a cover crop or green dressing. The nuts are large, and the yield good.

In Dominica, the trials have been generally successful. A light soil such as is suitable to the crop is not difficult to find in parts of the island, and the opinion is expressed that the crop should be of use, particularly to peasant proprietors, (*Report on the Botanic Station, Experiment Plots and Agricultural School*, Dominica, 1907-8, p. 31). The ill effect of a heavy soil is well shown by the results obtained in Antigua. In both islands the soil was carefully freed from weeds and well prepared, but the results obtained in Antigua were unsatisfactory.

Another point that appears is the advantage of a dressing of lime, in Montserrat and Nevis. In Montserrat, the application was at the rate of 10 cwt. per acre; in Nevis at that of 1,200 lb. per acre. Trials with lime were also conducted in Dominica in 1909. A small plot was planted with nuts (the variety is not recorded) and half of it was limed with slaked lime at the rate of 13½ cwt. per acre. The limed half gave a yield of 12 lb. of nuts, the unlimed 9 lb. The result was, however, considerably interfered with by attacks of diseases. In 1910 the trial was repeated in Dominica with a new variety, Virginia Bunch. The area planted was 2,451 sq.feet, and half of it received a dressing of lime at the rate of 8 oz. to the square yard, or 2,420 lb. per acre. The limed portion yielded a crop at the rate of 3,080 lb. of cured nuts per acre, while the yield from the unlimed plot was at the rate of 2,880 lb. per acre. Thus, lime would appear to be desirable as a dressing in Dominica, also. The evidence as to the advantage of this in Antigua and St. Kitts is somewhat indefinite.

In general, it seems that in the islands named in the table, with the possible exception of Antigua and St. Lucia, imported varieties of ground nuts will probably prove advantageous, more especially as they become acclimatized, and in consequence, less liable to disease.

In order to obtain plants of the imported varieties which are likely to give the largest yields, it is necessary to plant nuts of these varieties obtained from plants grown in the previous season in any given island, and not to plant freshly imported nuts each year. If this process is continued through several years, a strain of plants is obtained which is adapted to the local conditions, and is therefore hardy. This acclimatization is probably taking place owing to unconscious selection as much as to any other factor. In connexion with the acclimatization process, artificial selection of the best nuts from the most promising plants may also be conducted for planting purposes. Work of this kind is being done by Mr. Robson, Curator of the Botanic Station, Montserrat. There is no doubt that the effect of acclimatization and artificial selection will be to produce a strain of plants, of any of the improved varieties, well adapted to West Indian conditions.

EXPERIMENTS IN DOMINICA.

As has been stated already, these were conducted by Mr. J. A. Brooks, formerly Officer-in-charge of the Agricultural School, Dominica, now Assistant Curator, St. Lucia ; it is from the report furnished by him that the following information is taken.

Disinfection of Seed.—The first point that suggested itself for determination was the effect of disinfecting the nuts with a solution of corrosive sublimate, to destroy the root fungus on their surfaces, and to prevent if possible the rotting of the nuts of the Dixie Giant variety, which had been observed in several of the islands where these were planted.

Preliminary experiments appeared to indicate that treatment of the nuts with 1 in 1,000 corrosive sublimate solution did not reduce the germinating power, if the nuts were washed after this ; while the reduction was small, even when washing was omitted.

Although the omission of washing appeared to reduce slightly the germinating power of the nuts, no serious harm was done by disinfection without washing. Consequently, it was decided to immerse the nuts for five minutes, without subsequent washing, before planting on a field scale.

In order to test the effect of this treatment on a field scale, an area of 2,556 sq. feet was planted with nuts of the Spanish variety. The area was divided into two equal parts labelled A and B. One and a half pounds of nuts were sown in each part, in rows 2 feet apart, and at intervals of 1 foot in the row between each hole. The nuts were planted 2 inches deep and two were put in each hole. Planting was carried out in July. The nuts in section A were disinfected before being sown, as described above ; those in section B were untreated. The plots were reaped in the middle of November. Section A gave a yield of 74¾ lb. of cured nuts. Section B yielded 69⅞ lb.

While the plots were free from root disease and leaf spot, the rust fungus appeared on the treated section on October 13, and, as no remedies were applied, it spread throughout the plot. It did not appear in section B until November 3, and even then the plants nearest those in section A were unaffected.

Effect of the Rust Fungus.—The results obtained above also throw some interesting light on the effect of the rust fungus, as they indicate that this does very little harm. No individual plant was killed outright, either in this or in any of the plots. It did not alter the generally healthy appearance of the plot, as it showed only on the older leaves and those nearest the ground. It was observed, also, that all the nuts from attacked plants were perfectly healthy, and showed no signs of shrinkage. Furthermore, a comparison of the number and total weight of the nuts borne on plants attacked by this disease with those of the nuts borne on healthy plants revealed no differences, so that in Dominica, under the conditions of the experiment, the rust fungus cannot be said to cause any very serious injury. The fungus appeared sporadically at different dates, in October, on plots situated some distance from one another, and attacked firstly those plants obtained from disinfected seed. There is, at present, no evidence as to the source of infection, and the land used had not been planted in ground nuts during the previous year.

Comparison of Varieties.—A plot of a total area of 4,400 sq. feet was divided into five equal parts and planted with nuts of the Spanish, Tennessee Red, Dixie Giant and Carolina Running varieties. The nuts were sown in rows 2 feet apart with 2 feet between the holes in the row. Two nuts were placed in each hole, at a depth of 2 inches. Sowing took place in July.

The nuts used were saved from the crop of 1909 and were all attacked by the root fungus, the mycelium being observed on their surfaces. They were disinfected for five minutes, without subsequent washing. In addition, one of the five plots was planted with nuts of the Spanish variety which were obtained fresh from America and were not disinfected.

The yields were as follows :—

Variety.	Actual yield in pounds.		Estimated yield per acre in pounds.	
	Uncured.	Cured.	Uncured.	Cured.
Spanish (untreated)	19	15½	940½	767
Spanish (disinfected)	27	22	1,336½	1,089
Tennessee Red ..	29	24½	1,435	1,213
Dixie Giant	118	73¾	5,841	3,523
Carolina Running ...	108	76	5,346	3,762

The Dixie Giant and Carolina Running varieties gave by far the highest yields, and bore the largest nuts. Unfortunately they are but little suited to the conditions of the market in Dominica, where small nuts are preferred, as they are sold by measure.

The disinfection treatment seemed to have prevented any occurrence of root disease, even from the diseased nuts used for planting and, moreover, appeared to have acted as a stimulant, as it very probably accounts for the difference in yield between the treated and untreated plots of the Spanish variety. The rust fungus, however, broke out on the Carolina Running variety on October 5, when the diseased plant was removed, and the surrounding plants dusted once a week with a mixture of equal parts of lime and sulphur.

On November 3, the rust fungus appeared on the section planted with the untreated seed of the Spanish variety, at the end of the plot remote from the Carolina Running plants. The other three sections, containing Dixie Giant, Tennessee Red, and the disinfected Spanish, were free from disease. The sporadic nature of the attacks of the rust fungus on this plot suggests an outside source of infection. This has, however, not been discovered. On the whole, lime-sulphur mixture appears to have but little effect on the spread of this disease.

The Effect of Lime.—In order to test the effect of a dressing of lime at the rate of ½-lb. to the square yard, or 2,420 lb. to the acre, a plot of 2,451 square feet was divided into two sections, A and B. Section A received a dressing of lime ; section B did not. Both sections were planted with nuts of the Virginia Bunch variety, in rows 2 feet apart with a space of 1 foot between the holes. One seed was sown in each hole.

The rust fungus broke out on section A, on October 6, and on section B twelve days later, so that its effect, if any, was much the same on both sections. It is worthy of note that the lime-sulphur mixture which was applied had but little apparent effect on checking the disease.

The plot was reaped on November 15, practically four months from the day of planting. Section A, the limed portion, gave a yield of 86⅝ lb. of cured nuts, or an estimated yield of 3,080 lb. of cured nuts, per acre. Section B gave an actual yield of 81 lb. of cured nuts or an estimated yield of 2,880 lb per acre. This gives an increase of 200 lb. per acre of cured nuts in favour of the limed section—an increase so small as to render the experiment inconclusive.

The Effect of Unleached Wood Ashes.—To test this a plot the area of which was 3,234 square feet was divided into two sections, A and B. Section A was the control plot, section B received a dressing of 10 oz. of wood ashes to the square yard or 3,025 lb. per acre. The plot was planted with nuts of the Virginia Runner variety, planting being carried out as in the case of the Virginia Bunch variety used in the lime experiment.

The rust fungus occurred on both the plots at about the same time, and was not checked to any great extent by applications of the lime-sulphur mixture.

Reaping was carried out on November 16, the nuts taking four months to mature. Section A—the control plot—gave an actual yield of 155¼ lb. of cured nuts, or an estimated yield of 4,182 lb. per acre. Section B gave an actual yield of 156 lb. of cured nuts, or an estimated yield of 4,202 lb. per acre. This gives an increase of 20 lb. per acre in favour of the wood ashes plot—a result which is so small as to be negligible. It may be noted, however, that the seeds arrived late, so that the dressing was on the ground for three months instead of not more than two weeks, before the nuts were planted.

In conclusion, then, it would appear that disinfection of seed is a desirable practice; that in Dominica the Carolina Running and Dixie Giant varieties give the biggest yields, though they are not as desirable for the local market as varieties producing smaller nuts; that a dressing of lime of about 2,000 lb. to the acre is likely to prove advantageous; and that the rust fungus does not cause shrinkage of the nuts, or inflict any other serious damage in that island.

SELECTION EXPERIMENTS IN MONTSERRAT.

In the *Report on the Botanic Station and Experiment Plots*, Montserrat, 1909-10, mention is made of selection experiments with plants of the Gambia and Carolina Running varieties. The results obtained are interesting, and although the work has only been started recently, there is evidence to show that careful selection of seed from the best plants for planting purposes will have a considerable effect in increasing the yield and other desirable characters of these nuts.

GENERAL CONCLUSIONS.

(1) The disinfection of ground nuts, by immersion for five minutes in a solution of corrosive sublimate of a strength of 1 part in 1,000 of water before planting, is a course highly to be recommended.

(2) The varieties most suitable to the different islands vary somewhat with the locality, but the Spanish and Carolina Running varieties are likely to prove most generally useful.

(3) An application of 1,200 to 2,400 lb. of lime per acre to the soil in which this crop is to be grown is likely to prove advantageous, at any rate in the islands of Dominica, Montserrat and Nevis.

(4) The effect of gradual acclimatization may do much to reduce the harm inflicted by fungi, and, in conjunction with seed selection, to increase the yield given by the different varieties; so that a really useful addition to the agriculture of the islands will accrue by the extended cultivation of ground nuts.

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REPORT ON A VISIT TO FLORIDA.

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[During his recent leave in the United States, Mr. Ballou visited Florida for the purpose of making observations on the practice of controlling the insect pests of citrus trees by means of natural enemies. Mr. Ballou's report on this visit is given herewith.—Ed., *W.I.B.*]

On October 12, I left Washington at 4 05 p.m. by the Atlantic Coast Line train for Florida, arriving at Gainesville at about 5.30 the next afternoon. On the following day, the 14th, I went to the Florida State University where I called on Professor P. H. Rolfs, Director of the Experiment Station, and met Professor H. S. Fawcett, Plant Pathologist, and other Experiment Station officers.

The new Experiment Station building was being finished, and most of the departments were getting settled in their new quarters. This building, being especially designed for the purpose, combines in a remarkable degree attractiveness and utility. The offices, laboratories, and photographic rooms are commodious and very well arranged.

I was very much interested in the work of the station in general, as well as along the lines of my special mission. One of the most interesting of these, and one which shows remarkable progress is the improvement of the quality and yield of Indian corn. Professor Rolfs informed me that the average yield in the State was about 12 to 13 bushels per acre, but that crops of 100 bushels were often produced under careful treatment, and the record yield was very much more than that. When it is borne in mind that corn grown under Florida conditions, which yields not more than 15 bushels per acre, does not give a profit, these figures are remarkable. In Bulletin No. 100 of the Florida Experiment Station, entitled *Corn*, by Professor P. H. Rolfs, the following figures are given:—

Yield of corn in Florida :—

1908 : 4,351,000 bushels, at the rate of 10·5 bushels per acre.
1909 : 8.379,000 „ „ „ „ „ 12·6 „ „ „

Value of principal crops in Florida, 1908.

Oranges	$4,221,000
Cotton (Sea Island, and upland)	$3,653,000
Corn	$3,409,000

In a corn test in a number of counties in Florida in 1909, the corn exhibits were judged by an expert from Illinois. The exhibit which won first prize was awarded only 60 per cent. of the total marks indicated by the score card. These figures show that corn is a crop of considerable value in Florida, in spite of the fact that the average yield for the whole State is lower than that at which the crop gives a profit. The larger yields are produced at a slightly greater cost per bushel, and the profits are very considerable when they approach the record figures given above. When it is remembered that only 60 per cent. of the score card points have been gained in some of the best yields, it will be seen that, in spite of the improvement made already, much remains to be done.

The figures relating to yield and general improvement are of special interest when compared with the conditions existing in certain of the West Indian islands, where large amounts of corn are imported, and where it is planted as a catch crop, or one of minor importance. Good corn can be raised in these islands, and with the proper methods of improvement by selection, and of curing and storing, this crop might easily become of much greater consequence than it is at present.

Great activity is shown in the development of the cultivation of small fruits and vegetables for the northern market, also. Certain districts raise particular crops, such as strawberries, tomatos, cucumbers, musk melons, water melons, pineapples, and Irish potatos, some of which are coming into serious competition with the greenhouse and field crops of the north.

CITRUS PESTS AND THEIR NATURAL ENEMIES.

The principal object of my visit was the study of the orange and grape-fruit cultivations, with special reference to the insect pests and their control by means of natural enemies.

I visited the towns of Gainesville, Deland and Orlando, in the order mentioned. Gainesville is the seat of the State University and Experiment Station, and is sufficiently far north to experience a degree of cold often inimical to successful orange cultivation. Orlando, on the other hand, about 100 miles farther south, is in a very successful orange-growing district, and it is in this town that the United States Department of Agriculture, through its Bureau of Entomology, has established a station for conducting experiments in the control of the white fly. Deland is some 40 miles north of Orlando.

In all my visits to the orange and grape-fruit orchards I was accompanied by Professor H. S. Fawcett, Plant Pathologist to the Florida Experiment Station. The visits were planned in consultation with Professor P. H. Rolfs, the Director of the Station. Before proceeding to Florida I had written regarding my visit to Dr. Howard at Washington, who referred me to Dr. E. A. Back, in charge of the Federal Station at Orlando. Dr. Back was about to start on a trip to Cuba, but he advised me with regard to localities which might profitably be visited; these were the same as those suggested by Professors Rolfs and Fawcett, and an attempt was made to visit as many of these as was possible in the time available. The distance to be travelled and the difficulties of making good train connexions in Florida cause it to be impossible to accomplish as much as one would expect, when not familiar with the conditions.

On the morning following my arrival in Gainesville, I called on Professor Rolfs, and discussed with him and Professor Fawcett the objects of my visit and the localities which would be likely to afford good examples of the control of pests of citrus trees by means of natural enemies. Arrangements were made for visiting Deland and Orlando, after seeing what there was of interest in this connexion in Gainesville. New Smyrna, St. Petersburgh and Daytona were also suggested, but the time available was not sufficient, on account of the difficulty of making good railroad connexions.

CITRUS PESTS IN FLORIDA.

The principal pest of citrus fruits in Florida is the orange white fly (*Aleyrodes citri*). Associated with this insect there is, in many localities, another species called the cloudy-wing white fly (*Aleyrodes nubifera*, Berger) which was studied and described by Dr. E. W. Berger, Entomologist to the Florida Agricultural Experiment Station. In addition to these, a species, *Aleyrodes howardi*, has been found seriously to attack oranges, in a few localities. This last has been known as a pest of citrus trees in Cuba, but has only recently been recorded in Florida.

Aleyrodes citri is by far the most abundant of the white flies and the most difficult to control, largely on account of its power of rapid increase in numbers, and the great variety of non-citrus plants on which it can live.

The injury caused by this pest is most generally ascribed to the effects of the sooty mould, or black blight. That is to say, black blight makes very vigorous growth wherever white fly is established, and when the attack of white fly is very severe the black blight covers fruits, leaves and bark with such a dense layer of growth as to interfere seriously with the function of assimilation, and also to necessitate the washing of the fruit before packing.

The attacks of white fly do not appear to injure the leaves of the plants to the same extent that the purple scale does in the West Indies. The position of each group of purple scales on leaves of orange or lime in the West Indies is indicated by a discoloured spot, but no such sign of the presence of white fly was noticed in Florida. Although the attacks of white fly result in loss of vigour of the trees, and reduced yields of fruit, I did not see any trees in the dying condition so often observed in West Indian lime cultivations where serious attacks of purple scale have been experienced.

The purple scale (*Lepidosaphes beckii*) and Glover's scale (*L. gloveri*) occur in Florida on citrus trees, but I saw no signs of a serious attack by these insects. Both these scales are known in the West Indies, the former (*L. beckii*) being the principal pest of limes in Dominica and Montserrat.

The Florida red scale (*Chrysomphalus ficus*) is fairly abundant, but is not usually a serious pest. This scale also occurs in the West Indies.

The orange rust mite (*Phytophus oleivorus*) occurs in Florida, producing 'russet' oranges and 'silvery' grape-fruit and lemons, but I saw no evidence of serious attack in any of the groves I visited. This mite also occurs in the West Indies, but is not sufficiently abundant to be considered a pest.

The orange dog (larva of *Papilio cresphontes*) sometimes eats the leaves of orange trees, but is not often a pest in Florida. It is reported to be more troublesome in Cuba. There are several species of plant bugs (Hemiptera) which injure the ripening orange and tangerine fruits, causing them to drop. The injury from these insects is due to the punctures made by the sucking mouth parts, and is similar to that observed in the Botanic Station at Dominica and reported from Nevis, which is caused by a lepidopterous insect (*Didonis biblis*). The insects concerned in causing this injury and loss are: the cotton stainer (*Dysdercus suturellus*), a green plant bug or bugs (*Nezara* sp. or spp.), a brown bug (possibly *Euschites*), and several others.

AMOUNT OF DAMAGE BY CITRUS PESTS.

Severe attacks of white fly often result in a loss equal to 50 per cent., or more, of the crop; the injury to the trees and the expense of washing the fruit necessitated by the presence of black blight have not been taken into account in this estimate. In many cases, the attacks of this insect render orange-growing unprofitable; but this does not usually happen when cultivation and manuring of the groves receive proper attention.

The purple and long scales cause a considerable amount of injury to the trees, and in addition they are the source of great expense in the preparation of fruit for market. These scales often occur on the fruit, and even though they are removed by hard scrubbing, the fruit often sells at much less than that which was grown clean, so that the difference in price and the cost of cleaning are losses caused by the scale insect.

The rust mite is said to be fairly abundant in certain parts of the State. One grower told me that it is a common practice to apply sulphur once or twice each season as a precaution. The sulphur is sprayed on, in a mixture with water, or applied dry, mixed in equal parts with lime. This dry mixture is broadcasted from the hand over the trees, in the same way that seed is sometimes sown. The best time for employing the dry mixture is, of course, when the leaves are wet with dew or rain.

CONTROL OF CITRUS PESTS.

The insect pests of citrus plants in Florida have been controlled by fumigating, by spraying, and by means of natural enemies.

The work of fumigating has been the subject of extended investigations by the Bureau of Entomology of the United States Department of Agriculture, through experts and special agents stationed at Orlando. Results of a great deal of this work were published in Bulletin No. 76 of the Bureau of Entomology, entitled *Fumigation for the Citrus White Fly, as Adapted to Florida Conditions*, by A. W. Morrill, Ph. D. 1908. The report also gives results of spraying with insecticides for white fly and scale insects.

NATURAL ENEMIES OF WHITE FLY AND SCALE INSECTS.

As has been stated already, the principal citrus pest is the citrus white fly (*Aleyrodes citri*, R. & H.). Other species of white fly are the cloudy-wing white fly (*A. nubifera*, Berger, and Howard's white fly (*A. howardi*, Quaintance).

In addition to these, there are the purple scale (*Lepidosaphes beckii*), the long or Glover's scale (*L. gloveri*), and the Florida red scale (*Chrysomphalus ficus*).

The principal enemies of the white flies are fungoid. Their names and the dates of their discovery on white fly in Florida are given herewith:—

Red fungus (*Aschersonia aleyrodis*, Webber) 1893.
Yellow „ (*Aschersonia flavo-citrino*, P. Henn.) 1893.
Brown fungus (*Aegeritis webberi*, Fawcett) 1896.
Cinnamon (*Verticillium heterocladum*, Penzig.) 1907.
White fringe fungus (*Microcera* sp. 1907.)
„ „ „ (*Sporotrichum* sp.)
Red-headed fungus (*Sphaerostilbe coccophila*) 1903.

Scale insects are attacked by the following natural enemies :—

Red-headed fungus (*Sphaerostilbe coccophila*).
White-headed „ (*Ophionectria coccicola*).
Black fungus (*Myriangium Duriaei*) Mont.

From this, it will be seen that the red-headed fungus attacks both white fly and scales, while the white-headed and the black fungi attack scale insects only.

I saw, in the groves visited, the citrus white fly (A. *citri*), the cloudy-wing white fly (*A. nubifera*), and the purple scale (*L. beckii*). These were all attacked by fungi and apparently well controlled, in nearly every instance. I saw all the species of fungus attacking white fly, and the red-headed fungus on the purple scale.

The fungus, as the word is commonly used in Florida, refers to the red Aschersonia, as that is the chief fungus on the principal pest; the other species are ordinarily designated by their common names.

The red Aschersonia in full possession of a tree badly infested with white fly is a most remarkable and conspicuous sight. Every leaf and seemingly every bit of the under surface of every leaf is taken up by the large, red fungus pustules. This is the most conspicuous and the most effective of all the fungus parasites of the white fly. The brown fungus is very useful, and very abundant in certain localities. This parasite has the power of sending out its mycelial hyphae in search of other insects and these growths sometimes extend over the leaf, down the petiole to the twig and up, on to other leaves. This habit is another method of spreading, in addition to the distribution of spores.

The yellow fungus makes its best and most rapid development on the cloudy-wing white fly (*A. nubifera*).

The degree of control of the white fly by the fungi was remarkable: on some trees from 93-98 per cent. of the flies were estimated to be killed, and in most groves the proportion was probably higher than 60 per cent.

The source of infection and the conditions under which the fungus grew were various. There were orchards in which the fungus had come in without any assistance or interference; others where the spores had been sprayed in with one spraying, with two sprayings, and with three sprayings; still others where the fungus had been sprayed in after the orchards had been sprayed with whale oil soap; and others yet, where, after the trees had been twice sprayed with whale oil soap, the fungus had come in and assumed control. All these orchards appeared to me to be in much the same condition, a very large percentage of the fly having been killed in each case. There was a small amount of black blight to be seen in every grove, but probably not enough to make any difference to the growth of the plants. Probably most of the fruit would have to be washed, and in fact it seems part of the general practice to wash all oranges and grapefruit in Florida.

I was much struck by the scarcity of scale insects in the groves visited. In nearly every instance, the purple scale was to be made out only by the red-headed fungus, which had already killed it. I very rarely saw any scales unattacked. The orange snow scale, I am informed, does not occur in Florida, nor the green scale (*Coccus viridis*) [Lecanium viride]. In most parts of Florida, the climatic conditions during 1910 have been very favourable for the development of beneficial fungi.

In Gainesville, Professor Fawcett and I visited the nurseries of Mr. S. C. Graves. In Deland, accompanied by Mr. H. B. Stevens, we spent the afternoon visiting orchards. At Orlando, we drove to Winter Park and saw several groves on the way. We also visited the grove of Mr. Palmer and the nurseries of Mr. Boone, who sells fungus. We also went to the estate of Mr. Stewart at Zellwood. On our drive to Winter Park we came across a small number of trees which evidently had not been cultivated for several years, and here we saw all the scale insects and the white fly well established and well controlled. These trees had a considerable amount of dead wood among the branches, and the foliage was rather yellow, but the pests were not specially abundant; and as has been stated already, they seemed to be well controlled. I was told that, at St. Petersburg, on the West Coast of the State, near Tampa, the red fungus, on account of dry weather, had failed to take possession after it had been artificially introduced.

The absence of signs of hymenopterous parasites of scale insects was a very noticeable feature. Even in those instances

After the plants are well grown and the roots have taken possession of the soil, no deep tillage is given. Weed growths, beggar weed, or other covers are harrowed in during the early part of the year, and later either the weeds are allowed to grow, or another crop of beggar weed is sown.

CONCLUSION.

Before closing this report, I wish to express my appreciation of the kindness of Professor P. H. Rolfs and of Professor H. S. Fawcett. Professor Rolfs took a great interest in my visit, and very kindly detailed Professor Fawcett to accompany me on the trip to Deland and Orlando. Professor Fawcett was most kind, and his knowledge of the field conditions, of the railways and time-tables, and his personal acquaintance with orange growers and the managers of large properties, made it possible to accomplish a great deal more than I could have done otherwise.

I desire also to express thanks to Dr. E. A. Back and Mr. W. W. Yothers, of the United States White Fly Station at Orlando, for courtesy shown during my visit.

SUMMARY.

The citrus white fly is the principal insect pest of citrus trees in Florida. Two other species of white fly occur, which are of minor importance. The purple, long, and Florida red scales also occur in Florida, as citrus pests generally of less importance than the white fly.

These insect pests are capable of being held in check, generally, by means of beneficial fungi, of which nine species are found in the State. Six of these are known to occur on white fly—one on both white fly and scales, and two on scales. In years of abundant moisture, the fungi naturally assume a varying degree of control of white fly and scale insect pests. In other seasons, they may be established during short rainy periods by artificial means, of which the spore-spraying method is the most satisfactory. Even in favourable seasons, fungi may be assisted to assume control more quickly by artificial introduction. Some six to eight weeks may be gained in this way.

When, for any reason, the pests become so numerous that treatment is required at once, the trees may be sprayed with oily or soap mixtures, or fumigated, without injury to the fungi.

Hymenopterous parasites do not appear to exert any influence in the control of these pests.

The rust mite occurs in the State as a pest of citrus trees, but is held in efficient check by the regular use of sulphur, applied dry or in water.

Cover crops and mulches act as aids in increasing moisture, and thus help to preserve conditions favourable for the growth of beneficial fungi.

Nitrogenous fertilizers are used sparingly.

Only shallow tillage is given, after the roots of the plants in the citrus groves have taken possession of the soil.

COMPARISON OF CONDITIONS IN FLORIDA WITH THOSE IN THE WEST INDIES.

It has been shown in this report that the white fly is the principal pest in Florida, and that fungi are the chief natural enemies. In the West Indies, conditions are different; scale insects are the principal pests of citrus crops, and their natural enemies include both fungi and parasitic insects. In Dominica, the fungi are perhaps in largest abundance, and this is probably largely due to the greater moisture of the atmosphere in this island ; while in Montserrat the beneficial effect is probably more equally divided between fungi and parasitic insects. In Florida, the cover crops of beggar weed and the natural growth of grass and weeds are considered to be an aid to the maintenance of the moist atmospheric conditions which are favourable to the development of the fungi, although the humidity of the atmosphere in Florida is very considerable, without any such aid. In Montserrat, the use of Bengal beans has been presumed to aid in the control of scale insects in a similar way, but it has not yet been proved that the use of this crop as a cover to lime trees increases greatly the amount of scale-attacking fungus. The experiments with limes in Montserrat, quoted in a recent number *of the *West Indian Bulletin*, indicate that a soil cover of grass and weeds has a beneficial effect in the control of scale insects. About twenty years ago, these insects were the principal pests of citrus cultivations in Florida, and the white fly, probably of more recent introduction than the scale insects, has increased until it holds the position of first importance in this regard. It is not possible at this time to say whether experience in the West Indies will be similar to that in Florida, but in this connexion it is especially desirable that a careful investigation of the species of white fly occurring in the West Indies should be made, with notes on their distribution and food plants, in order that records may be available ; so that from time to time in the future it may be possible to determine whether or not a decided increase of this class of pest is occurring.

The following publications are of interest in connexion with the control of white fly in Florida :—

Florida Experiment Station : —

Bulletin 88, January 1907.	White Fly Conditions in 1906. E. W. Berger.
Bulletin 94, July 1908.	Fungus Diseases of Scale Insects and White Fly. P. H. Rolfs and H. S. Fawcett.
Bulletin 97, February 1909.	White Fly Studies in 1908. E. W. Berger.

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*In this connexion reference is made to two papers in Vol XI, No. 1, of the *West Indian Bulletin* : ' Control of Scale Insects in the British West Indies by means of Fungoid Parasites, ' by F. W. South, B.A.: p. 1 ; and ' Notes on Lime Cultivation ', by H. A. Ballou, M. Sc.: p. 39.

Annual Report for 1907-8, Rep. Entom. pp. xlviii-lxiii. Rep. Asst. Pl. Pathol, pp. lxiv-lxxxix.

Annual Report for 1908-9, Rep. Entom, pp. xxxv-xlv.

U.S. Dept. Agric., Bur. Entom :—

Bulletin 76, Fumigation for the Citrus White Fly as adapted to Florida Conditions. By A. W. Morrill, Ph. D. 1908.

Imperial Depart. Agric. :—

W.I.B., Vol. XI. p. 1. The Control of Scale Insects in the British West Indies by means of Fungoid Parasites, by F. W. South, B.A.

W.I.B., Vol. XI, p. 39. Notes on Lime Cultivation, by H. A. Ballou, M. Sc.

A LIST OF THE BIRDS OF THE ISLAND OF ST. LUCIA.

BY AUSTIN H. CLARK, B.A., F.R.G.S.

[The following list of its brids, together with remarks on the protection of the native species, has been prepared by Mr. Austin H. Clark, B.A., F.R.G.S., of the Smithsonian Institution, Washington, for publication in St. Lucia. As, however, the special facilities for such publication are not available at present, the matter is reproduced here, in view of the general interest that it bears in relation to the West Indies, particularly in regard to the last part of the paper, embodying Mr. Clark's opinions on the protection of native birds.—Ed., *W.I.B.*]

LIST OF THE BIRDS RECORDED FROM THE ISLAND OF ST. LUCIA.

1. *Phaëthon æthereus* Linn.—Paille-en-queue. Bo's'n. Red-billed Tropic bird.
2. *Sula Leucogastra* (Bodd.)—Fou. Booby. Ballahoo.
3. *Fregata aquila* (Linn.)—Cobbler. Frigate Bird. Man-o'-War Bird.
4. *Florida cærulea cærulescens* (Lath.)—Little Blue Gaulding. White Gaulding.
5 *Butorides virescens maculata* (Bodd.)—Caylie. Hyallee. Little Crabier. Green Bittern.
6. *Nyctanassa violacea* (Linn.)—Crabier. Yellow-crowned Night Heron.
7. *Falco sparverius caribbearum* (Gmel.)—Gret-gru falaise. Gli-gli. Kili Hawk.
8 *Buteo antillarum* Clark.—Gree-gree. Mal-fini. Chicken Hawk.
9. *Urubitinga anthracina cancrivora* Clark. St. Vincent Crab Hawk,

LIST OF BIRDS FROM THE ISLAND OF ST. LUCIA.—*Continued.*

10 *Ionornis martinica* (Linn.)—Poule d'eau. Cascambiol. Water Fowl. Coot. Purple Gallinule.
11. *Gallinula galeata* (Licht.)—Red-seal Coot. Waterfowl.
12. *Ægialitis semipalmata* (Bonap.)—Bécasse à collier.
13. *Arenaria interpres* (Linn.)—Calico Bird. Rock Plover. Turnstone.
14. *Pisobia fuscicollis* (Vieill.)—Bécasse. Grey Nit. White-rumped Sandpiper.
15. *Pisobia minutilla* (Vieill.)—Cockroach Nit. Least Sandpiper.
16. *Totanus melanoleucus* Gmel.—Pika. Greater Yellow-legs.
17. *Totanus flavipes* Gmel.—Long-legs. Yellow-legs.
18. *Helodromas solitarius* (Wils.)—Black-back Solitary Sandpiper.
19. *Actitis macularia* (Linn.)—Tivi-tivi. Spotted Wag. Spotted Sandpiper.
20. *Columba squamosa* Bonn.—Ramier.
21. *Zenaida zenaida aurita* (Temm.)—Tourterelle. Wood Dove. Seaside Dove.
22. *Chamæpelia passerina trochila* (Bonap.)—Ortolan. Ground Dove.
23. *Geotrygon montana* (Linn.)—Perdrix. Rouce. Quail Dove.
24. *Geotrygon mystacea* (Temm.)—Perdrix Croissant. Quail Dove.
25. *Coccyzus minor minor* (Gmel.)—Coucou-manioc Rain Bird.
26. *Coccyzus minor vincentis* Clark—Coucou-manioc. Rain Bird.
27. *Crotophaga ani* Linn.—Merle Corbeau. Tick Bird. Keel-bill. Black Witch.
28. *Amazona versicolor* (Müll.)—St. Lucia Parrot. Perroquet. Jacquot.
29. *Ceryle alcyon* (Linn.)—Pie. Kingfisher. Loggerhead. Mango Bird
30. *Chætura acuta* (Gmel.)—Lesser Antillean Swift.
31. *Antrostomus rufus* (Bodd.) Cent coups de couteau.
32. *Eulampis jugularis* (Linn.)—Bronze-winged Humming Bird. Red-throated Humming Bird.
33. *Sericotes holosericeus* (Linn.)—Emerald Humming Bird. Videt-throated Humming Bird.
34. *Microlyssa exilis* (Gmel.)—Gold-headed Humming Bird. Bee Humming Bird.
35. *Tyrannus dominicensis rostratus* Scl.—Pipperie. Rain Bird.
36. *Myiarchus tyrannulus oberi* Lawr.—Pipperie gran-bois. Pipperie gros-tête.
37. *Blacicus latirostris* (Verr.)—Gobe-mouche solitaire.
38. *Elainea martinica martinica* (Linn.)—Peewit. Yellow-bellied Topknot.
39. *Icterus laudabilis* Scl—Carrouge.
40. *Holoquiscalus inflexirostris* (Swains.)—Merle. Blackbird.
41. *Loxigilla noctis sclateri* Allen—Père noir. Robin. See-see Sparrow. Mayson.
42. *Melanospiza richardsoni* (Cory.)—Black Finch.
43. *Tiaris bicolor omissa* (Jard.)—Grass Sparrow. Cane Sparrow. See-see Zerbe.
44. *Saltator guadeloupensis* Lafr.—Gros-bec.
45. *Euphonia flavifrons viscivora* Clark.—Moisson à couleurs. Louis d'or, Blue head. Mistletoe Bird. Perish.
46. *Progne dominicensis* (Linn.)—White-bellied Swallow. West Indian Martin.

LIST OF BIRDS FROM THE ISLAND OF ST. LUCIA.—*Continued.*

47. *Vireosylva calidris barbadensis* Ridgw.—Mabelle. Lady Bird. Ladies' Related. Pegree.
48. *Cœreba martinicana* (Reich.)—Sucrière. See-see. Martinique Honey-creeper.
49. *Dendroica delicata* Ridgw.—Sucrière grand-bois. Sucrier babad.
50. *Dendroica striata* (Forst.)—Swamp Sparrow. Black-polled Warbler.
51. *Leucopeza semperi* (Scl.)—Pied-blanc.
52. *Seiurus aurocapillus* (Linn.)—Oven Bird. Golden-crowned Thrush.
53. *Setophaga ruticilla* (Linn.)—Carrougette Goldfinch. Christmas Bird. American Redstart.
54 *Troglodytes mesoleucus* Scl.—Rossignol. God Bird. St. Lucia Wren.
55. *Rhamphocinclus brachyurus sanctæluciæ* Cory.—Gorge-blanc.
56. *Cichlherminia sanctæluciæ* Stejn.—Molvie. Mauvie.
57. *Myiadestes sanctæluciæ* Stejn.—Siffleur montaigne.
58. *Cinclocerthia macrorhyncha* Scl —Le trembleur.
59. *Mimus gilvus* (Vieill).—Grieve blanc. Pied carreau. Mocking-bird.
60. *Allenia albiventris* (Lawr.)—Grevotte. Grivotte. Spotted Grieve.
61. *Margarops fuscatus densirostris* (Vieill.)—Mocking-thrush.

LIST OF BIRDS UNDOUBTEDLY OCCURRING ON OR ABOUT ST. LUCIA, BUT WHICH HAVE NOT YET BEEN ACTUALLY TAKEN THERE

Porzana carolina (Linn.)—Sora. Rail.
Fulica caribæa Ridgw.—Poule d'eau. Waterfowl. White-seal Coot.
Squatarola squatarola (Linn.)—Loggerhead. White-tailed Plover.
Charadrius dominicus (Mull.)—Golden Plover.
Gallinago delicata (Ord.) Wilson's Snipe.
Macrorhamphus griseus (Gmel.)—Duck-leg. Duck-bill. Dowitcher.
Pisobia maculata (Vieill.)—Chirp. October Chirp. Pectoral Sand-piper.
Ereunetes pusillus (Linn.)—Grass Nit Semipalmated Sand-piper.
Calidris leucophæa Pall—Sandy Snipe. Sanderling.
Limosa hœmastica (Linn.)—Hudsonian Godwit.
Catoptophorus semipalmatus (Gmel.)—White-tailed Curlew. Willet.
Bartramia longicauda (Bechst.)—Cotton-tree Plover.
Numenius borealis (Forst.)—Chittering Curlew. Eskimo Curlew.
Himantopus mexicanus (Mull.)—Black-necked Stilt.
Larus atricilla Linn.—Mauve. Laughing Gull.
Sterna maxima Bodd.—Royal Tern,
Sterna dougalli dougalli Mont.—Roseate Tern.
Sterna dougalli gracilis (Gould.)—Southern Roseate Tern. Carrect
Sterna fuscata Linn.—Swarco. Hurricane Bird. Sooty Tern.
Sterna anœthetus (Scop.)—Bridled Tern.
Anous stolidus (Linn.)—Mwen. Noddy.
Podilymbus podiceps (Linn.)—Two-penny Chick. Pied-billed Grebe
Oceanites oceanicus (Kuhl.)—Wilson's Petrel.
Puffinus lherminieri—Petit diablotin. Audubon's Shear-water.
Phaëthon americanus Grant.—Yellow-billed Tropic Bird.
Sula cyanops (Sund.)—Blue-faced Booby.

LIST OF BIRDS FROM THE ISLAND OF ST. LUCIA.—*Concluded.*

Sula piscator (Linn.)—Fou blanc. White Booby. White-tailed Booby.
Pelecanus occidentalis Linn.—Grand-gorge. Brown Pelican.
Ardea herodias Linn.—Crabier montaigne. Grey Gaulding. Great Blue Heron.
Egretta candidissima (Gmel.)—Snowy Heron.
Nycticorax nycticorax (Linn.)--Black-crowned Night Heron.
Querquedula discors (Linn.)—Blue-winged Teal.
Anas platyrhynchos Linn.—Mallard.
Spatula clypeata (Linn.)—Shoveller.
Erismatura jamaicensis—Red Diver. Ruddy Duck.
Dendrocygna discolor Scl. and Salv.—Whistling Duck. Tree Duck.
Falco peregrinus anatum (Bonap.)—Duck Hawk.
Falco columbarius Linn.—Pigeon Hawk.
Pandion haliaëtus carolinensis (Gmel)—Sea Hawk. Fish Hawk
Chordeiles virginianus (Gmel.)—Night Hawk.
Hirundo erythrogaster Bodd.—Barn Swallow.
Compsothlypis americana (Linn.)—Parula Warbler.
Dendroica ruficapilla (Gmel.)—Yellow Bird.
Seiurus noveboracensis (Gmel.)—Water Thrush.

THE PROTECTION OF THE NATIVE BIRDS OF ST. LUCIA.

INTRODUCTORY REMARKS.

The protection of the native birds, especially those partially or wholly insectivorous, is always a problem of the greatest importance to an agricultural country like St. Lucia. But here, there is much more than the usual need for a prompt and intelligent solution of the question. The introduction of the mongoose some years ago, while it has resulted beneficially in the diminution of the fer-de-lance (*Lachesis mutus*), has also resulted in the greater diminution, more or less unnoticed, in the numbers of the harmless, but extremely useful, insectivorous lizards. Such a condition may well have been responsible for the great increase of the screw worm fly (*Compsomyia* sp.), noticed a few years ago, just as it has been for the increase of the mole crickets in St. Vincent. The effect of the presence of the mongoose in increasing the numbers of insect pests may be partially, perhaps even entirely, offset by the encouragement of the native birds, each insectivorous lizard, lost beyond hope of recall, being supplanted by an insectivorous bird dependent upon the same food. We know of no means by which the lizards may be made to increase so long as the mongoose remains; propagation of the former would only result in increasing the food-supply of the latter; but most of the useful birds nest beyond the reach of the mongoose, so that their natural increase is not affected by it.

The nests and young of all the St. Lucia birds, with the sole exception, perhaps, of the Poule d'eau (see beyond) should be at all times strictly protected.

It is very important that the laws passed protecting the birds of St. Lucia be founded on a strictly economic basis.

There has been in many countries a tendency to base laws regulating the killing of birds upon sentimental rather than upon practical grounds, which has sometimes led to popular disapproval and subsequent disastrous modification or repeal.

At the present time, we are admittedly without adequate data in regard to the economic value of the birds of St. Lucia, so that it is necessary to base many of our recommendations upon the known habits of the same or allied species in adjacent islands. It would be a very great contribution to local agricultural science, as well as to science in general, if a systematic study of the stomach contents of St. Lucia birds were undertaken; much of great value could be learned if a hundred birds, say, of each species, killed at different seasons, were preserved in alcohol and sent to the United States Biological Survey (Department of Agriculture) at Washington, for examination.

Classes of Birds to be Protected.

For purposes of protection, the birds of St. Lucia may be divided into three general classes, as follows :—

(1) Game Birds,	(2) Birds of Plumage,	(3) Small Insectivorous birds,
(a) native,	(a) terrestrial,	(a) song birds,
(b) foreign.	(b) aquatic.	(b) songlessbirds.

GAME BIRDS.—The native birds of St. Lucia worthy to be classed as game, according to the commonly accepted standards prevailing in English-speaking communities, are ten in number, and are of sufficient importance to merit individual discussion.

First of all comes the beautiful Wood Pigeon or Ramier (*Columba squamosa*). Outside of the breeding season, this bird is usually well able to take care of itself, under ordinary conditions. In certain localities, however, it is often uncommonly tame and it has a habit of flying in large flocks at stated seasons very low over ridges of land, usually well known, where huge bags may be secured. Strict protection should be accorded for a long period covering the breeding season, and at all times in certain localities, more particularly those including the nesting sites. The export of the birds, cooked or uncooked, should be prohibited. Limitation of the size of the bag would be desirable, and it would be well to prevent the sale of the birds in the open market.

This bird was formerly very abundant throughout the Windward Islands, occurring at certain seasons even on Barbados where now it is quite unknown. Every effort should be made to encourage its propagation.

The most interesting St. Lucia game bird, from all points of view, is the beautiful native parrot (*Amazona versicolor*) which is found nowhere else, being replaced on St. Vincent by the magnificent brown St. Vincent parrot (*A. guildingii*), and on Martinique by the (now extinct) Martinican parrot (*A. martinicana*).

History has shown that the birds of the parrot tribe are usually the first to be exterminated in any given area. In the

West Indies, the large and handsome macaws, formerly abundant on Jamaica, Cuba, Haiti, Guadeloupe, Dominica and Martinique have long ceased to inhabit those islands; so long ago, indeed, were they exterminated that specimens of only one of them, the Cuban species (*Ara tricolor*), exist to-day in museums, and all knowledge of them has passed from the traditions of the natives. The parrots of Guadeloupe and Martinique (six in number), as well as the macaw and the parrakeet of Dominica, seem to have disappeared about two hundred years ago, while those of St Vincent and the Bahamas are on the verge of extinction. Parakeets, once abundant on Barbados (in the Scotland district), on Martinique, Dominica, and Guadeloupe, are now no longer known from those islands, and no specimens of them have ever been preserved.

There are several reasons for the early extinction of the parrots. First of all they learn to talk, and are therefore always the most prized of avian pets. This leads to a wholesale traffic in young birds, the nesting sites being sometimes so closely watched that scarcely any free young are permitted to remain. Again, they are rather particular in their choice of food, being especially fond of the fruit of certain forest trees. These trees usually grow widely scattered in the woods, and are readily found by the fragments of fruit torn off by the birds littering the ground beneath them. Once one of these trees is discovered, a hunter has merely to sit under it and shoot the parrots as they come in. Parrots are unfortunate in having a most extraordinary amount of sympathy, a characteristic which is recognized in the vernacular name of 'love bird' applied to many of the smaller species. When one of a pair or even one of a large flock is wounded or killed, the others, no matter how wild and unapproachable they may have been before, at once become tame and lose all fear of the hunter in their solicitude for their unfortunate companion. Thus if one of a flock be wounded so that it cannot get away it is usually easy to get all or most of the rest, and wild parrots may be easily secured by allowing a tame one, with a line attached to its leg, to take a prominent position in a tree, pulling the line at intervals so that it will cry out.

A very short open season should be allowed for parrots, if it be thought advisable to consider them as game at all, until their numbers shall have increased to far beyond what they are at present; and this open season should be removed as far as possible from the months during which mating and nesting take place. The taking of eggs and young, the use of decoy birds, and the shooting of the birds on or near the nesting sites should be strictly prohibited. The high cash value of the St. Lucia parrots, either alive or as museum specimens, makes it necessary to impose especially heavy penalties for the infringement of any law regarding them.

The Seaside or Wood Dove (*Zenaida zenaida aurita*) is of some importance as a game bird, though as a rule not molested if the larger Ramier is available; the same law should be made to cover both these species.

The two species of Mountain Quail doves or Perdix (*Geotrygon mystacea* and *G. montana*) have both, I understand become very rare except in isolated and remote sections of the island, as a result of the ravages of the mongoose; both should be rigidly protected at all seasons, though it is probable that, even with the best protection, both will entirely disappear within a few years.

The Little Ortolan or Ground Dove, though small, furnishes excellent sport and is a food bird by no means to be despised. It should be accorded judicious protection, preferably under a general Doves and Pigeons Paragraph along with the Ramier and the Seaside Dove; but it is probable that in the not far distant future it will die out in spite of anything that can be done, as it forms one of the chief dainties of the mongoose.

The Molvie or Mauvie (*Cichlherminia sanctæluciæ*) and the Grevotte (*Allenia albiventris*), though small, are included among the game birds of St. Lucia, and many are killed annually. Judging from the habits of these and allied species in adjacent islands, they should be struck from the 'game' list and accorded protection throughout the year, on account of the great good which they do in destroying insects. From the point of view of agricultural economics it is unwise to class as 'game' any bird, no matter how large or toothsome it may be, which is emphatically beneficial.

Two other St. Lucia birds are, in the American tropics, commonly classed as game birds, and serve commonly as articles of diet. The more important of these is the Crabier or Yellow-crown Night Gaulding (*Nyctanassa violacea*), which is common in all marsh districts. This bird is of distinct economic value in keeping down the numbers of land crabs, which form a very large part of its food, and it should, therefore, be accorded an ample measure of protection. Although large, it is rather a stupid bird and very easy to shoot, especially just at nightfall, when it emerges from the swamps and flies low over the pastures hunting for crabs, and on moonlight nights. The shooting of this bird between sunset and sunrise should be forbidden at all seasons.

The other is the Gree-gree or Chicken Hawk (*Buteo antillarum*). This bird is also easy to shoot when once you understand its habits; it is also very readily caught by placing a steel trap on a post or other conspicuous object in an open field. On the island of St. Vincent, I found this hawk to be of the greatest benefit to agriculture, as it feeds very largely on the mole crickets. Before the introduction of the mongoose, its diet consisted mainly of lizards, but now that the lizards are greatly reduced in numbers and the mole crickets have become abundant its habits have changed. Economically, the lizards are much more valuable than the hawks as insect destroyers; but the hawks are far better than none at all. Of course this bird cannot resist an occasional chicken, though it does not often kill them—not nearly so often as its vernacular English name would imply. It would have to kill far more chickens than it does to offset its value as an enemy to large insects. It should certainly be strictly protected at all times.

The foreign game birds of St. Lucia include the Curlew, Plover, Snipe, Sandpipers, etc., collectively usually known as

Shore Birds (Limicolae), and the more or less irregular visiting ducks. These birds come in the late summer or autumn, usually passing beyond to South America. They sometimes reappear in the spring on their way to their North American breeding grounds. As a rule, the larger shore birds pass St. Lucia to the eastward, going even to the eastward of Barbados; but in some seasons they alight in considerable numbers. There is no evidence that any persecution to which they might be subjected on the island would tend to diminish their numbers, and there is no reason for placing any close season upon them, though it might be well to put a reasonable limit upon the number which could be killed in any one day. All the shore birds known from St. Lucia are North American, most of them coming from the far northern portions of that continent, and many even from the Arctic regions. The ducks are stragglers from either North or South America, though possibly three of the smaller ones, the Masked Duck (*Nomonyx dominicus*), the Red Diver or Ruddy Duck (*Erismatura jamaicensis*), and the Blue-winged Teal (*Querquedula discors*), breed locally. This should be determined as soon as possible. The first named is said to breed on Guadeloupe and Dominica, and the other two breed in the Grenadines on Carriacou and on Isle Ronde, so that it would not be surprising to find them breeding on St. Lucia.

BIRDS OF PLUMAGE.. There are no terrestrial plume birds of commercial importance on St. Lucia, though the skins of three species, the Carrouge (*Icterus laudabilis*), the Sucrière (*Corereba martinicana*), the Moisson à couleurs (*Euphonia flavifrons viscivora*) and the three Humming Birds would probably find a ready market. The skins of the native parrot (discussed above under Game Birds) would undoubtedly meet with a ready sale at a good price, as a result of the restrictions placed upon the traffic in birds by most tropical Governments at the present time.

Among the Waders and Water Birds, the Tropic birds, the Terns and the Gulls, as well as certain of the Herons, are adorned with saleable feathers, while there is always more or less demand for those of the large Sea Birds, such as Mano' War Birds, Boobies, and Pelicans. By common consent among the more enlightened Governments, the exploitation of avian resources for commercial purposes, excepting only to a limited extent as game, is prohibited.

SMALL INSECTIVOROUS BIRDS. The necessity for the strict protection of all the small insectivorous birds in an agricultural community is so patent as not to require any arguments to emphasize it. As a rule a distinction is made between the Song Birds and the Songless Birds, but such discrimination is usually uncalled for, as well as unnecessary and confusing, for the term 'Song Bird' is very difficult of definition, and therefore hard to maintain. If any such distinction is made, of course a greater penalty should be inflicted in the case of the Song Birds (especially *Myiadestes sanctaeluciae* and *Mimus gilvus*), for the reason that their commercial value as cage birds gives an added stimulus to their capture and exportation.

INJURIOUS BIRDS. Several of the native birds of St. Lucia have the reputation of being more or less destructive to growing crops, or to other forms of animal life of more economic importance than themselves.

The Gros-bec (*Saltator guadeloupensis*) is perhaps the most notorious of these, being said to be very destructive to the pigeon pea. It is highly probable, however, that the damage done is more than offset by the enormous numbers of insects killed, especially at the time when the young are in the nest.

The Père-noir (*Loxigilla noctis sclateri*) and the Carrouge (*Icterus laudabilis*) are reported to be destructive to growing canes, especially the former, which digs out a small hole to get at the pith, this eventually causing the death of the cane. The harm done, however, is undoubtedly more than counterbalanced by the good service wrought by these two species in killing insects.

The Poule d'eau (*Ionornis martinica*), here as elsewhere, is an adept plantain and banana thief, and also destroys maize by climbing the stalks and tearing to pieces the ears. So far as is known, this bird has no economic value. Its depredations are confined to lands in the immediate vicinity of fresh-water swamps, where it may be very readily captured in fish traps baited with corn.

It might be advisable to permit the destruction of this bird, but *by trapping only*; by this method there is little danger of any other species being killed along with it, for if birds of other kinds were caught they could easily be liberated.

The small Waders and Shore Birds, as well as the Kingfisher or Pie (*Ceryle alcyon*) are all fond of small fish and undoubtedly eat many millions and tri-tri annually. Statistics on the subject are not available, and a study should be made of their stomach contents, taken at every season of the year, before they are exempted from protection on that account.

INTRODUCTION OF FOREIGN BIRDS.

The introduction of foreign birds should, I believe, be strictly prohibited; but if it be allowed, it should be only permitted upon the recommendation of an authoritative society such as the British Ornithologists' Union, or the Zoological Society.

Great harm—far more harm than good—has resulted from the indiscriminate introduction of birds and animals into new localities, and new experiments along this line should be firmly discouraged. Usually, the introduction of a bird into a new region is unsuccessful, the stock quickly dying out. Many instances of this are found in the ornithological history of Barbados and St. Vincent; but sometimes it is far too successful, and the interloper becomes a perfect nuisance, if not an actual pest.

Every new element introduced into a fauna necessitates a readjustment of the constituent elements of that fauna, exactly as the addition of one colour to another causes a modification of the original colour. A new balance must be struck. Under normal faunal conditions the native species, collectively, consume the entire available supply of food as rapidly as it is produced; the addition of a vigorous exotic species deprives a certain proportion of the original endemic species of their food-supply, and consequently, they gradually disappear, their disappearance being often hastened by hostility on the part of the intruder.

The history of the introduction of birds into new localities shows that, economically, it has very rarely been a success; and scientifically, the disturbance of the faunal conditions in an exceptionally interesting island—conditions duplicated nowhere else in the world—is greatly to be deplored.

COLLECTORS' PERMITS.

Provision should always be made, in framing a general statute covering the killing of birds, for a suspension of the law by the Governor-in-Council in favour of *bona fide* ornithologists, or the agents or collectors of *bona fide* ornithologists, who are desirous of securing a series of the birds of the Colony in the interests of science, without any idea of commercial gain.

It is often very difficult to determine the fitness and the general qualifications of a man locally, while at the same time it is imperative that only strictly reliable men should be allowed to operate. It is therefore advisable to stipulate that a prospective collector be furnished with credentials from the Royal Society, the Zoological Society, the Royal Geographical Society, or some other learned body, before he visits the Colony; and permits could be issued upon the presentation of such credentials to the Governor-in-Council. Such a course would work no hardship upon foreign ornithologists, for all the foreign ornithologists of good standing are well known in England, and the proverbial fairness of these great societies prevents even a thought of the possibility of discrimination against them.

In many Governments, permits are issued limiting the number of birds or nests to be taken, or limiting the killing to the so-called 'open season'. This has often been a severe handicap to the scientific ornithologist, minimizing the value of his researches and, unless he be endowed with almost superhuman honesty, usually driving him into a deplorable disregard for the law. To take an illustration: suppose a man wished to compare the Red-throated Humming Bird of St. Lucia with the same bird on St. Vincent and on the other islands near by, and were only allowed to shoot two (a common limitation). There is no way of distinguishing the sexes in life until one has formed a very intimate acquaintance with the bird, as the colouration is exactly the same; but the male has a slightly shorter bill than the female. If he secured two females on St. Lucia, and two males, say, on St. Vincent, so far as a comparison of the birds of the two islands is concerned, from a scientific standpoint, he might just as well have no birds at all. It is always necessary to have a good series of birds of each species upon which to base conclusions, and with which to make comparisons with the birds from neighbouring localities; and besides the adults, one should have the eggs and nests, and the young in all stages. No museum at the present time contains a sufficient representation of the birds of St. Lucia for a satisfactory study of even the commonest species. Intelligent research into the ornithology of the island should by all means be encouraged, and visiting collectors bringing credentials satisfactory to the Governor-in-Council should be allowed to carry on their work unhampered by restrictions of any sort (excepting, perhaps, in regard to the parrots) until such a time as the ornithology of the Colony is well understood,

Power of revoking any permit at any time should, of course, always be retained by the Governor, to guard against possible abuse of the privileges conferred.

A NOTE ON THE INTRODUCTION OF BIRDS.

In relation to the matter contained in the foregoing article, an abstract of information given recently, in the *Hawaiian Forester and Agriculturist* for Februray 1911, will not be out of place. The subject-matter of this article consists of a report presenting suggestions by Professor H. W. Henshaw, Chief of the United States Biological Survey, in reply to a request from Mr. E. M. Ehrhorn, Superintendent of Entomology, Board of Commissioners of Agriculture and Forestry, Honolulu, Hawaii.

It is first pointed out that no safe dependence is to be placed on the habits and standing of a bird in its own home, when an attempt is being made to estimate its probable behaviour after introduction into a country to which it is not native. It is thus evident that attempts to introduce a new species into a country must be regarded as being of a purely experimental nature, until the bird has been observed carefully for some time, and certain knowledge has been obtained of its habits in its new surroundings.

An axiom in regard to the introduction of birds is stated to the effect that this should never be brought about, as regards agricultural countries, in the case of those which are largely fruit and seed eaters. In a more particular way, the same is true of the bird called the bobolink and all kinds of blackbirds, especially in the former case where rice is grown. It is possible that, as regards blackbirds, the species called Brewer's blackbird might be regarded as an exception, although it would have to be watched carefully, chiefly because of its gregarious habits, and the consequent possibility of its doing much harm, once a commencement of bad habits had been made.

The small spotted woodpeckers are regarded with favour, among them being Gairdner's woodpecker (*Dryobates pubescens gairdneri*) and Nuttall's woodpecker (*D. nuttalli*), which are both found in California. Among birds which destroy scale insects, any of those called by the name 'chickadee', such as the plain titmouse (*Bæolophus inornatus inornatus*), mountain chickadee (*Penthestes gambeli gambeli*), California chickadee (*P. rufescens neglectus*), the bush tit (*Psaltriparus minimus minimus*), and the wren tit (*Chaemaea fasciata fasciata*) are recommended. All the fly-catchers are also considered to be useful, among these being Say's fly-catcher (*Sayornis sayus*), the black fly-catcher of California (*S nigricans*) and the ash-throated fly-catcher (*Myiarchus cinerascens*). These are migratory, and on that account it would be better to select tropical species of fly-catchers which do not possess this characteristic ; among these are Mexican species of Myiarchus, Pitanga and Myiozetetes.

Birds further mentioned favourably for introduction are any species of swallow or night-hawk, with special reference to the purple martin of North Mexico and the tropical swallow (*Tachycineta albilinea*), found on the Mexican coast. The mocking bird is also recommended, on account of its general interest and the fact that it is almost exclusively insectivorous while breeding, and possesses this characteristic to a great extent during the rest of the year ; the recommendation is not however, made without reserve. Another bird that is considered worthy of trial is known as the Pekin nightingale or Japanese robin (*Liothrix lutea*). This lives on insects, and to some extent on small fruits. It may be easily obtained from bird dealers in San Francisco, information in regard to the securing of these and other Californian birds being probably best obtainable from Mr. J. Grinnell, Museum of Vertebrate Zoology, California University, Berkeley, California.

The raising of the ordinary game birds in Hawaii has been accompanied by the same difficulties as obtain in parts of the West Indies, on account of the presence of the mongoose. It is therefore suggested that future trials with gallinaceous birds should be made with the Mexican chachalaca (*Ortalis* sp), guan (*Penelope* sp.), and currassow (*Crax* sp), which feed on wild berries and insects, and what is more important, in relation to the mongoose, build their nests in forest trees, at a good height from the ground. Other useful characteristics possessed by them are that they are tamed readily, and run well with the ordinary domestic fowl ; the first-mentioned bird seems to be best suited to the drier regions, while the last thrives well in those which are damp.

In conclusion, the opinion is expressed that all the above-named birds, with the possible exception of the migratory species, should thrive in Hawaii. The usefulness is suggested of making more than one attempt at introduction, in the case of any given bird, particularly as the insect eaters are much less hardy than those which live on fruits and seed. In any case, the work requires the considerable expenditure of money and trouble, and this is why evidence is available of so few well-conducted experiments in connexion with the introduction of birds.

AN ACCOUNT OF THE WORKING OF THE LAND SETTLEMENT SCHEME IN ST. VINCENT.

BY W. N. SANDS,
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The Land Settlement Scheme of St. Vincent is probably the largest and most comprehensive of its kind yet attempted in any of the British West Indian Colonies, so that an account of the working of it during the past ten years, more particularly from an agricultural standpoint, may be of interest.

The scheme owes its existence to the West Indian Royal Commission of 1897. The Royal Commission, after going very fully into the condition of the peasantry of St. Vincent, reported as follows, in paragraphs 374-8 of their report:—

> 374. We have already made a general recommendation that the settlement of the Creole population of the West Indies as cultivating proprietors should be recognized as the settled policy of the Government of the different Colonies, and we see no reason to depart from that policy in the case of St. Vincent. On the contrary, it seems to us that, whether the sugar industry is maintained or disappears, it is absolutely essential in the interest of the native population that their settlement on the land should be facilitated; in no other way does it seem to us to be possible to maintain even the most moderate degree of prosperity in St. Vincent.
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> 375. At the same time the question is surrounded with special difficulties in the case of this island. There is, no doubt, a large extent of Crown land, but this land is situated in the centre of the island, at a considerable elevation, remote from the markets, and is unprovided with roads. A great deal of the land consists of steep slopes difficult to cultivate, and liable to suffer from heavy rains and floods.
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> 376. The attempts that have been made in recent years to settle cultivators on the Crown lands have not so far met with much success. A considerable number of plots were taken up, to be paid for in instalments, but the owners complained of the want of roads. They have suffered from the low prices of produce, and owing to the general depression they have found themselves unable to get work so as to earn the wages on which they relied in some degree to pay for their holdings. In 1896 many of these holdings were damaged by floods, to an extent which has made it difficult or impossible for the purchasers to pay the instalments due, whilst much of their cultivation has been swept away. Whether the attempt to settle the population on the Crown lands under such conditions ultimately proves successful or not, we are convinced that it does not afford any prospect of providing in sufficient time for the bulk of the population likely to be thrown out of employment by the stoppage of the sugar-cane cultiva-

tion, and we are doubtful whether it is expedient to reduce largely the area of the central forests; a reduction which is inevitable if the lands are occupied by settlers.

377. There are, however, round the sea-coast thousands of acres of fertile land in the hands of private owners uncultivated and likely to remain so. The holders of the lands appear to be unwilling to sell them in small lots or at a reasonable price, and are unable to cultivate them. Under the circumstances, we have no hesitation in recommending that suitable portions of these lands be acquired by the State and made available for settlement in small plots. If suitable lands cannot be obtained by private agreement with the owners, powers should be taken by the Government to expropriate them on payment of reasonable compensation. The condition of St. Vincent is so critical as to justify the adoption of prompt and drastic measures of reform. A monopoly of the most accessible and fertile lands by a few persons who are unable any longer to make a beneficial use of them cannot, in the general interest of the island, be tolerated, and is a source of public danger.

378. The determination of the particular lands to be acquired by the State, and the detailed arrangements to be made for settling proprietary cultivators on them must be left in the hands of those who possess greater local experience than we can pretend to. The cost of such a measure will be considerable, but need not be very heavy. We see no likelihood of the Colony of St. Vincent being able to meet it, and we recommend that it be borne by the Imperial Government.

It will be seen that a very critical state of affairs existed in 1897, which was greatly intensified by the effects of a disastrous hurricane in the month of September of the following year.

Acting on the recommendations of the Royal Commission, the Imperial Government made a Grant-in-aid of £15,000, to the local Government, for the purpose of purchasing estates and settling the peasantry on them: but before the grant could be utilized it was found necessary to pass an Ordinance to authorize the acquisition of estates. This Ordinance was known as the Land Settlement Ordinance, 1899. Under it, power was given to the Governor-in-Council to select, purchase, and take possession of lands; to appoint a Land Commissioner and other officers; to make regulations for carrying into effect the purpose of the Ordinance; and for regulating the system of establishing and locating small holders on land acquired under its provisions.

During the year 1899, several estates in different parts of the island were acquired, namely, Cumberland Valley, 1,470 acres; Linley Valley, 1,571 acres; New Adelphi and Park Hill, 1,101 acres; Richmond Hill, 285 acres; and Clare Valley—Questelles, 633 acres. The total area of these was 5,060 acres. As soon as possible after the estates were taken over, the lands were surveyed and split up into a large number of small holdings. The area of the larger number of holdings averaged 5 acres. There were 633 of these, but there were also 82 having an area of about 1 acre each. Reserves were made (a) of half a chain around the sources of important streams, (b) of exposed ridges and such forest as was considered necessary for forest conservation, (c) of land necessary for public purposes, such as sites for churches, chapels and schools, (d) of land required for roads and paths, and (e) of land for townships.

The total cost of acquisition, including legal and survey fees, was £14,706. The value of each small holding was apportioned so that the total valuation should be equal to the total amount of the expenses incurred by the Government in the purchase of the whole area, plus interest at the rate of 3 per cent. for twelve years. Each applicant was required to pay 25 per cent. of the value of a small holding before being allowed to occupy it. The balance of the value of the land was divided up into twelve equal parts ; one had to be paid before the expiration of the fifth year from the date of the provisional permit to occupy the lot, and the remaining parts by annual instalments, so that each small holder was allowed sixteen years to complete the purchase of his land. A steady and industrious applicant, who was not able to pay 25 per cent. of the value of a small holding at once, was allowed to occupy the land on his agreeing to pay the amount in four successive annual instalments, the first to be paid before the expiration of one year after the date of the permit to occupy the lot, and the balance of the value in the manner described above. The conditions of tenure stipulated that each small holder should reside on his holding, or on a house spot in one or other of the townships which were formed, unless he had been granted permission by the Governor-in-Council to reside elsewhere. There were other conditions, but the one of chief interest from an agricultural point of view read as follows :—

> Every purchaser shall carry out such instructions as to the area of cultivation, the nature of products to be planted in a particular spot, the manner in which the land is to be cultivated and the products cared for, and the handling of the products for market as may from time to time be given to him by the Officers of the Imperial Department of Agriculture for the West Indies.

The introduction of the new scheme was not received with favour by some estate owners, for they anticipated that there would be a serious shortage of labour by settling such a large number of people on the acquired lands, and they were also of opinion that the peasants would become so independent of ordinary estate work that it would not be possible for them (the estate owners) to carry on their cultivations in a profitable manner. On the other hand, there was a good deal of dissatisfaction and suspicion among the peasants themselves, and at first the action of the local Government was much criticised. Some of the peasants thought, in view of the fact that the Imperial Government had made a grant for the purchase of lands, that they should not be called upon to pay for the holdings; others thought that the Government would retake the lands after they had put them into cultivation. Some would not accept free supplies of useful plants for the same reason. The eruptions of the Soufrière in 1902 also had a demoralizing effect, and it was difficult to get some of the small holders to pay their instalments. There were other difficulties which had to be met at the outset, but happily, most of them have long since been surmounted.

The administrative and financial sides of the scheme have been controlled by the Land Commissioner. Financially it has proved a success, for the Land Commissioner was able to report on March 31, 1910, that there was £7,964 to the credit of it, notwithstanding that no less than £6,572 had been spent on roads and byways, wages, rest houses for officers, wind-breaks, awards and prizes to small holders, etc., in addition to the cost of acquiring the estates. The amount expended on roads and byways alone totalled £3,781. Quite recently, the operations of the scheme have been extended by the purchase of Union Island, containing 2,600 acres of land, for £5,000, and at the present time the Government is in treaty for 400 acres of Fair Hall estate near Calliaqua. As soon as the surveys are completed, the peasantry will be allowed to purchase lands for small holdings at those places, on somewhat similar terms to those laid down in the original regulations.

On March 31, 1910, it was further reported that there were fifty lots with a total area of 272 acres on hand. These lots are for the most part in places where it is difficult to get access to them: besides, a number have land too poor and steep for profitable cultivation. For lots that are favourably situated in regard to roads, and where the land is not too difficult to work, there is keen competition at the present time.

The foregoing is a brief outline of the scheme and its present position.

The efforts of the Agricultural Department have been chiefly directed to the instruction of the small holders in the best manner of cultivating their lands and crops and preparing their produce for market; besides, the Department has annually raised and distributed many thousands of useful plants and seeds to them, free of cost.

In order that the Department might keep in close touch with each small holder and see that the instructions given are carried out, an Agricultural Instructor was appointed, whose duties are chiefly concerned with the Land Settlement estates. He is required to submit a monthly report to the Agricultural Superintendent, for transmission to the Administrator and Imperial Commissioner of Agriculture. This report gives an account of the estates visited; the condition of crops; instructions given to small holders; the number of economic plants distributed; the progress made with the making and ultilization of manure and compost; and any other information likely to be of interest. His work is supervised by the Agricultural Superintendent, who pays periodical visits of general inspection. A small holder who refuses to carry out instructions, or who neglects his holding, is first of all warned that unless he gives his land and crops the necessary attention his holding will be forfeited. Should he persist in his neglect, a recommendation for the forfeiture of his holding is submitted by the Agricultural Superintendent to the Administrator. Fortunately, it has only been found necessary to forfeit a few small holdings for this reason.

The estates, with the exception of Clare Valley—Questelles and Richmond Hill, are situated in mountainous districts and extend for a considerable distance inland. There is very little level land, but the cultivable area is fairly well worked by the small holders.

The principal crops grown are cotton, ground provisions, arrowroot, cassava, cacao, ground nuts, pigeon peas, Indian corn, sugar-cane, plantains and bananas. A considerable proportion of several of these crops is annually exported to neighbouring colonies. The cotton, however, is nearly all sold to the Government, or to local dealers, for export to the United Kingdom. Besides growing these crops for export and local use. the people rear a large number of cattle and small stock on their lands, to send to other islands for sale.

Although it is not possible to ascertain correctly the quantity of the output from the Land Settlement estates it may be taken for granted that a large proportion of the exports shown in the following list came from them. The items and values are taken from the official Blue Books of the past five years.

LIST OF EXPORTS OF GROUND PROVISIONS, SMALL S

YEAR.	ARTICLES.							
	Sweet potatos.	Tanias.	Yams.			Ground nuts.	Farine.	Plantains.
	bags.	bags.	bags.	brls	number	bushels.	lb.	b'nche
1905-6.								
Quantity	9,554	2,551	1,735	150¼	7,334	9,918	88,789	2,08
Value £	1,949	708	...	..	687	2,445	378	104
1906-7.								
Quantity	5,560¾	2,557¾	1,856½	77	8,605	7,684½	64,478	2,16
Value £	1,118	705	...	...	650	1,929	286	107
1907-8.								
Quantity	4,803	1,719	1,035½	186	8,346	6,360	40,764	1,08
Value £	1,044	507	. .	.	521	1,589	174	57
1908-9.								
Quantity	6,418	2,320	1,232	121¼	13,878	8,869	76,271	1,85
Value £	1,361	613	...	...	423	1,740	328	98
1909.								
Quantity	5,199¼	2,334 8½ casks	1,909¼	109¼	8,308	5,815½	47,900	57
Value £	1,070	671	..	...	673	1,480	229	29

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Although it is not possible to ascertain correctly the quantity of the output from the Land Settlement estates it may be taken for granted that a large proportion of the exports shown in the following list came from them. The items and values are taken from the official Blue Books of the past five years.

LIST OF EXPORTS OF GROUND PROVISIONS, SMALL STOCK, ETC., 1905-6 to 1909.

Year.	Articles.													
	Sweet potatos.	Tanias.	Yams.			Ground nuts.	Farine.	Plantains.	Fowls.	Eggs.	Goats.	Pigs.	Sheep	Total.
	bags.	bags.	bags.	brls	number	bushels	lb	b'nches		doz.				£
1905-6.														
Quantity	9,554	2,551	1,735	150¼	7,334	9,818	88,789	2,087	1,550	442	3,220	2,288	768	
Value £	1,949	708	..	.	687	2,445	378	104	76	11	888	1,538	384	9,168
1906-7.														
Quantity	5,560¾	2,557¾	1,856½	77	8,605	7,684½	64,478	2,160	2,064	1,122	2,891	2,186	468	
Value £	1,118	705	..	...	650	1,929	286	107	105	28	824	2,186	236	8,174
1907-8.														
Quantity	4,803	1,719	1,035½	186	8,346	6,360	40,764	1,088	1,527	1,794	2,451	1,575	601	
Value £	1,044	507	.		521	1,589	174	57	77	49	678	1,569	296	6,561
1908-9.														
Quantity	6,418	2,320	1,232	121¼	13,878	8,869	76,271	1,858	1,814	3,192	1,973	1,573	524	
Value £	1,361	613	..	..	423	1,740	328	98	87	73	526	1,564	211	7,024
1909.														
Quantity	5,199¼	2,334 8½ casks	1,909¼	109¼	8,308	5,815½	47,900	572	2,360	4,170	2,437	1,563	638	
Value £	1,070	671	..	..	673	1,480	229	29	117	104	676	1,563	319	6,931

By far the largest acreage is cultivated in ground provisions, but a fairly large area is planted in cassava for making farine and cassava starch. Among other crops are Indian corn, pigeon peas and ground nuts. It is a fortunate circumstance that the small holders have found a ready market for their surplus produce in Trinidad, Grenada and some of the Grenadines. In Trinidad, also, there is a good market for small stock and poultry, while Barbados takes a large number of cattle in each season These intercolonial markets are within easy sailing distance of St. Vincent. It is undoubtedly due in no small measure to the fact that the small holders have been able to dispose of large quantities of ground provisions and other produce, and stock, at fair prices in these intercolonial markets, that the scheme has proved a success. Had there been no such outlet, it is likely that a large number of them would have had to eke out a hand to mouth existence, and besides, would not have been able to pay for their lands. There is, however, much room for improvement in the methods of shipment to, and the disposal of produce and stock in, other islands. The small holders often have to place their shipments in the hands of the captains or stevedores of the sloops and schooners plying between the islands. Some of these men do not always deal fairly with the people, and it is no uncommon thing for sums to be paid which are far below those actually realized. It should be possible to put this intercolonial trade on a better footing, provided that the small holders could be got to work together on co-operative lines. At the present time, however, the cultivation of cotton is being rapidly extended, which circumstance. with the possible increase, also, of arrowroot planting will no doubt lead to a reduction in the area cultivated in ground provision crops. With a smaller output, and an increase in the local demand, it appears unlikely that those who continue to grow ground provisions will have to rely so much on the intercolonial markets, in order to dispose of their crops at a profit.

Arrowroot is another product which is produced on a fairly large scale on some estates, more particularly New Adelphi and Park Hill, and is shipped to neighbouring colonies. At New Adelphi, the Government has erected a central arrowroot mill to assist the growers there. but on several of the other estates there are small mills owned and worked by the holders themselves. The arrowroot industry has for many years been in a depressed condition; so much so that neither the estate owners nor the peasantry of the island have been able to obtain paying prices for the starch, but recently an Arrowroot Growers' and Exporters' Association has been formed, to which nearly all the owners of private estates belong. The members of the Association have agreed not to sell arrowroot in the United Kingdom below 2*d.* per lb.—a figure which allows a fair profit to be made. One result of this is that the price now being obtained for arrowroot in the intercolonial markets is higher than the average price previously realized. Taken altogether, the outlook for arrowroot at the present time is much brighter, and it appears likely that its production will prove more remunerative in future than it has been for several years past.

Sugar-cane is grown chiefly at New Adelphi; here a sugar mill is also maintained by the Government. A small charge of 2*s*. per barrel of sugar, and 1*d* per gallon of syrup is made to the people for the use and upkeep of the works. These comprise an old muscovado sugar plant, and the loss of sugar through defective crushing of the cane, and in the handling of the juice is considerable; still, the system of manufacture is one which the small holders understand fairly well. It is doubtful if the industry has proved very remunerative, however, during the past three or four years, owing to the extension of cotton planting throughout the island, and the consequent reduction in the acreage planted in sugar-cane. The producers at New Adelphi have been able to dispose of their sugar and syrup, locally, at fairly good prices.

From the time the scheme was started, it was thought desirable to encourage the small growers to establish permanent crops on portions of their lands, in order that they might not have to depend so much on ground provision crops, sugar and arrowroot, and with this object in view, as has been mentioned before, a large number of cacao and other plants, but chiefly cacao, have been annually raised by the Agricultural Department and distributed free to them.

In order to ascertain the progress made, and to inspect the condition of the permanent economic plants cultivated, the Agricultural Superintendent made a complete tour through the districts toward the end of 1906, and the following extracts are taken from a report submitted by him to the Administrator.

> The chief permanent plant cultivated is cacao. Other permanent types grown in small numbers are—coffee, nutmegs, cocoa-nuts, and cinnamon, but they do not form an important feature and the produce is practically all consumed locally.
>
> When the estates were acquired by the Government, a number of established cacao trees were already growing on them, more particularly on those in the Linley and Cumberland Valleys. The total number of trees was probably about 6,250, but many were in an unsatisfactory condition Since 1900, the Imperial Department of Agriculture has encouraged the planting of cacao in places where it was thought it would do well. The Agricultural Instructor has selected suitable lands, and the small holders have planted them up according to instructions given.
>
> The Agricultural Department's nurseries for raising cacao and other plants were situated at the Botanic Station and the Georgetown Experiment Station. Besides small nurseries have been formed in the Linley and Cumberland Valleys for raising plants for the small holdings there. The latter were maintained from Land Settlement funds. In addition to the plants raised by the Department, a good many have been raised by the small holders themselves, and planted out on their lands.

As a result of the tour of inspection, it is estimated that the number of cacao trees and plants now growing on the estates in good or fair condition is fully 60,000, the larger portion of course being young plants.

The total amount of cacao produced at the present time on each estate has been carefully estimated with the following result:—

Estate.	Number of bags of cacao produced.
Linley Valley estates	30
Cumberland Valley estates	15
Clare Valley and Questelles	...
Richmond Hill	3-4
Park Hill	3
New Adelphi	1½
Total	52½-53½

It will be observed that the total estimated output of cacao is from 52½-53½ bags. With the exception of Clare Valley and Questelles, a progressive annual increase in yield is to be looked for from now onwards.

The area of the small holdings varies from 1 acre to 7½ acres. The number occupied at the end of the year was 584. Cacao-planting has been attempted on portions of no less than 369 with varying success. Some of the people have put in just a few plants and others a considerable number.

In order that an idea may be formed of the progress, or otherwise, made on the estates, a brief summary of each has been worked out. The condition of the trees and plants has been classed under three heads as follows:—

'Improved' means that the trees are making good progress, are well cared for, and that in most cases the cultivation has been extended.

'Fair' means that there is in the cultivation approximately the same number of trees as in 1904 when the census was taken, and that they are not making much progress.

'Poor' means that the trees are in poor condition through being planted in unfavourable situations or not well cared for.

The numbers in the summary are based on the figures given in 1904, as no later census has been taken.

GENERAL SUMMARY REGARDING ALL THE LAND SETTLEMENT ESTATES.

Estate.	No. of cacao plants improved.	No. of cacao plants fair.	No. of cacao plants poor.
Park Hill	2,180	2,616	1,074
New Adelphi	2,793	1,784	961
Richmond Hill	3,475	698	1,014
Clare Valley and Questelles	3,422	875	2,164
Cumberland Valley estate ..	9,437	3,026	6,147
Linley Valley estates .	16,465	4,873	8,976
Total*	36,402	13,272	20,436

The total number of plants in an 'improved' and 'fair' condition on all the estates, as shown in the list, is 49,674 as against 20,436 'poor'. In proportion to the total number of plants growing, Park Hill and New Adelphi show the best record of progress, although estates such as Rosebank and Belmont in the Linley Valley group would show a still better record if taken separately.

The progress made with the planting of permanent economic plants during the past few years has been considerable, notwithstanding that at the outset many difficulties were experienced.

Since 1906, work has been continued on much the same lines, and it is estimated that the quantity of cacao now produced annually is nearly double of that grown in 1906. The chief increases in yield have been obtained in the Linley Valley and at Park Hill; here there are some excellent cultivations giving satisfactory returns; on all the estates, however, with the exception of Clare Valley—Questelles, fair progress has been made.

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*The totals, as given, do not correspond to the items; they should be, reading from the left, 37,772, 13,872, and 20,336. The differences are, however, too small to affect the conclusions to be drawn from them.—Ed. *W.I.B.*

The following table shows the number of economic plants raised and distributed by the Agricultural Department free to small holders during the past ten years:—

Year.	Economic plants distributed.
1900	5,660
1901	7,679
1902-3	402 (year of eruption of Soufrière)
1903-4	5,325
1904-5	15,424
1905-6	11,770
1906-7	6,209
1907-8	3,325
1908-9	4,321
1909-10	3,804
Total	63,919.

Of the above total, no less than 53,000 were cacao plants.

With seed of good types of cacao now available on all the estates, small holders are able to raise their own plants, so that it has not been found necessary to continue the maintenance of nurseries at Georgetown and the Linley and Cumberland Valleys; the nursery at the Botanic Station has, however, been maintained.

The Agricultural Instructor has continued closely to watch the cultivations and give advice and instruction to the growers in regard to manuring, pruning and other matters, and his assistance is now much appreciated.

The progress made with cacao cultivation may be said to have been somewhat slow; still it should be mentioned that, under local conditions, cacao is rather a difficult crop to grow. The soils are, as a rule, too light and shallow, and it is only in sheltered places where there is a good depth of rich soil, and the rainfall is not excessive, that cacao thrives. Again, the small holders lack capital, and there have been no means by which they could obtain loans at a low rate of interest to establish cultivations; besides, they have not forgotten the disastrous hurricane of 1898, which destroyed nearly all the cacao plantations in the island. Under these circumstances, it is not to be expected that many of them, even if they had the money, would care to incur the expense and take the risk of planting, on any considerable scale, a crop which takes about seven years to reach a paying stage, since they are able to raise crops which give a quicker and more certain return on their outlay and for their labour.

From the experience gained, it is not considered desirable that the Agricultural Department should insist on any large extension of cacao planting, but should rather endeavour to induce the small holders to practise more intensive methods of cultivation of the plots that are already established and are promising well.

Excellent progress has been made with the cultivation of Sea Island cotton as an annual crop at Clare Valley—Questelles and parts of the Linley Valley and Richmond Hill estates. On these estates there are open lands near the coast. Unfortunately, the lands of the other estates are not suitable for cotton cultivation, so that the area available is limited.

Although the industry was introduced in 1903, it was not until 1906 that a serious attempt at cotton-planting was made by the small holders. In that year, 48 acres was planted, but since then there has been a progressive annual increase in the area cultivated, which during the present season has reached 290 acres. Of this total, Clare Valley—Questelles is represented by no less than 236 acres, and it is on this estate, therefore that most progress has been made.

The details for the several years are as follows:—

Season.	Area of cotton planted, Clare Valley—Questelles. Acres.
1906-7	11½
1907-8	50
1908-9	96½
1909-10	151
1910-11	236

The yield per acre for each season has been satisfactory. This is in no small measure due to the advice and instructions given by the Agricultural Instructor in regard to the crop.

It is estimated that the value of the present season's cotton crop grown on the Land Settlement estates will exceed £3,000, or an all-round gross value of over £10 per acre.

During the last season, the Government inaugurated a system whereby seed-cotton is purchased from small growers throughout the Colony on a profit-sharing, or co-operative basis, at the Government Cotton Ginnery. This has had an excellent effect, for besides ensuring that growers get a fair market price for their cotton, it induces them to put forth their best efforts in the cultivation of their lands, and has led to an extension of cotton-planting.

The system of purchasing cotton may be briefly described as follows.

Seed-cotton brought for sale is first of all graded, and then a price is paid which is equal to one-fifth of the estimated value of the lint, less 2c. per ℔. to cover freight and other charges. For instance, if the market value of first grade white lint is 37c. per ℔., the price paid for seed-cotton is 7c. per ℔. The seed is not returned to the grower, but retained to cover the cost of ginning and baling the lint; but should the proceeds of the sale of the seed exceed 1c. per ℔., the amount of the excess is added to the bonus distributed at the end of the season. The bonus distributed has been equal to four-fifths of the net profits made. This is calculated on a percentage basis on the amount paid on account to the growers. For example, if £1,800 is paid on account for seed-cotton, and at the end of the season it is found that the net profit made by the sale of lint and seed is £450, the amount available for distribution would be £360, which is equal to a bonus of 20 per cent. or 4*s*. for every quantity of seed-cotton sold worth £1.

The successful results already obtained under this system by the peasantry have ensured that a much larger acreage will be planted in cotton on the Land Settlement estates during the coming season.

Besides dealing with questions concerning the best manner of growing and handling different crops, the question of maintaining the fertility of the lands of the small holdings has received, and continues to receive, a good deal of attention on the part of the Officers of the Agricultural Department, and it is gratifying to note that very satisfactory progress has been made.

The small holders have had to be constantly instructed in the making of drains to prevent washing, the formation of compost heaps and manure pens, the growing of leguminous and other plants for green dressing purposes, the utilization of grass and bush as a mulch for permanent crops and for arrowroot, the rotation of crops, and in pasture fallowing. Further, in order to prevent waste of valuable organic matter, the burning of bush, except with the permission of the Agricultural Instructor, has been strictly prohibited.

Although a large measure of success has attended the efforts made with Land Settlement at St. Vincent, and most of the difficulties which presented themselves at the outset have been surmounted, still, when looked at to-day in the light of past experience, the scheme appears to be somewhat incomplete. Had it been possible to arrange agencies for the disposal, on co-operative lines, of the produce and stock of the small holders, and to form co-operative credit banks on the Raiffeisen system on the different estates, the scheme might have proved an even greater success.

In most countries where plans for the settlement of the people on the land are being carried out, these matters have received a great deal of attention; but whether success would have attended local efforts in this direction at the commencement of the scheme it is not possible to say, as the circumstances of the small holders now are quite different from those of ten years ago.

During the past two years, as was previously mentioned, the Government has successfully introduced a system for the purchase of cotton on a profit-sharing basis, but it is questionable if it would be wise to extend the system further so as to include other products, owing to the large amount of extra work and responsibility that it would involve. It should rather be left to the people themselves to form co-operative agencies for the purchase and sale of their produce, the Government of course giving all possible help and encouragement. At the present time agencies might be started for dealing with such products as cacao, arrowroot, cassava starch and ground nuts.

A few months ago, a small number of the better class of small holders at Clare Valley—Questelles formed an agricultural credit bank, and suitable rules embodying some of the best features of the Raiffeisen system were drawn up. The Government, in order to start the bank on a sound business footing, made a loan of £25 at 5 per cent. interest per annum. Should this pioneer bank prove a success, it is likely that others will be started in different districts on similar lines.

It will be seen that serious efforts have recently been undertaken to make the scheme more complete, and it is hoped that success will attend them.

THE SUGAR INDUSTRY OF THE ISLAND OF NEGROS.

BY AUSTIN H. KIRBY, B.A. (Cantab.),

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One of the latest publications of the Bureau of Science, Manila, entitled *The Sugar Industry in the Island of Negros*, by Herbert S. Walker, of the Division of Chemistry, Philippine Islands, is of much present interest as it deals with the sugar industry of Negros in the Philippines—an island which is already producing a large percentage of the sugar made in those islands, and is likely to increase greatly in importance in this connexion, in the near future. The interest of the publication, which deals very thoroughly with every branch of the subject described by it, has made it appear expedient that an abstract treating particularly of those parts of it that are of more immediate concern in relation to conditions in the West Indies should be given in this Journal.

The present importance of Negros, in relation to sugar production in the Philippines, is illustrated by the fact that, out of a total of about 107,000 tons made in the islands during 1907-8, 65,624 tons, or a little more than 40 per cent., was manufactured in that island. The year of largest production for the Philippines, namely 1893, saw more than one-third of this given by Negros. It will be shown later that the possession of fertile soils, together with virgin forest lands and rich alluvial deposits, should, with the adoption of modern methods of sugar manufacture, increase the output of sugar from Negros to an extent that will make it take a place of no little importance in the world's production of sugar.

The object of the work that is described was to gain an immediate knowledge of the conditions of agricultural practice in regard to the growing of sugar-cane and the making of sugar which actually prevail in Negros, for the ultimate purpose of obtaining information which will make it feasible to effect the advancement of the sugar industry. For the purpose six months, or practically the entire crop season of 1908-9, were spent in the island, during which time the work was conducted in the field and the factory, analyses of soil were made, and a study was undertaken of the economic conditions of the sugar industry in Negros.

GENERAL INFORMATION.

The situation of Negros is in 9° 4 to 11° 1′ north latitude and from 122° 24′ to 123° 34′ east longitude, so that the north of the island is in the latitude of Trinidad; while it is almost in the antipodes of that colony. It is practically surrounded by three other important islands: Panay, Mindanao and Cebu. Its chief shipping port for sugar is Iloilo, on the neighbouring island of Panay to the north-west, at a distance of 8 to 44 miles; the port is distant about 28 miles from the west coast, and 60 to 90 miles from the east coast. The greatest length of the island, which is shaped roughly like a boot, is 75 miles, with the largest breadth in the lower part 56 miles, that of the upper part being 25 to 40 miles. It is probable that the total area of the island is not known exactly; taking the average of the figures given, it should be 4,200 square miles, so that Negros is about 2½ times as large as the West Indian colony—Trinidad—already mentioned.

The greater part of the area is occupied by mountainous or hilly forest plains, the mountains extending the entire length of the island, but being nearer to the east than to the west coast; such land is uncultivated, except for patches that are cleared by burning and planted for a season or two in corn by the half wild inhabitants of this region. There is only one river that is navigable for vessels of any considerable draught: though three others form useful means of communication in some of the important sugar districts. The lack of rivers and harbours in Negros forms the reason why its sugar is not exported directly, but taken across to Iloilo in sailing vessels.

Dealing with Occidental Negros where, owing to the position of the chief mountain range that has been described already, the largest area of sugar production is situated, the records show that, during 1891 to 1898, January was the coolest month, with a temperature of 78·1° F.; April and May were the hottest, with 81·7° F., so that from this consideration alone the climate may be regarded as equable. The rainfall records. for the same district, during 1903-8, show that the driest periods are near the beginning and end of the year; while the greatest rainfall is received in the months immediately following the middle of the year. For instance, the average precipitation for January, February and March of that period was about 4½ inches, 2½ inches and ½-inch; in June it had increased to 9½ inches, followed by 14, 13, 12 and 9 inches during the next four months, respectively; in November and December it was 5½ and 8 · inches, the numbers being given in all cases to the nearest easy fraction of an inch. Returning again to the matter of temperature, the figures given above are for a station at La Carlota, one of the interior towns; the average of figures during 1903-8 for Bacolod, one of the coast towns, shows that the range is much the same, being from 79° F. to 83° F.; here the coolest months are January, February and August, while the hottest is May.

It has been indicated already that the sugar is mostly produced on the western side; the chief district occupies a plain having a width of 8 to 19 miles, all of which area is not suitable, however, for growing sugar-cane on account of the presence of swamps, and rocky and barren soils. On the east coast, there is no great coastal plain, and the sugar is produced in scattered areas of land in the valleys of small streams. These facts relate to the principal sugar-producing districts of the island; there are others lying between these, along the west coast, each of which produces a comparatively small amount of sugar; they are regarded as being separate from the other districts, because the means of communication with them are so difficult as to cause their comparative isolation.

Authorities state that the history of Negros, as a sugar-producing country, commences with the year 1849, at which time the island came under the jurisdiction of the religious order of the Recoletos, to whose efforts, ably assisted by the British Vice-Consul, Nicholas Loney, the rapid development of the industry during the next forty years is due. The extent of this increase is shown by the fact that, while in 1850, 170 tons of sugar was the total output, thirty years later this was 34,800 tons, while in 1893 it was 101,580 tons: the corresponding increase of the population is given as 30,000, 200,000 and 321,000. In the next two years—1893-5—the period of greatest prosperity was reached. Since this time, war and animal diseases have interfered with the industry so seriously that the total production has remained almost stationary during the past few years, at an amount reaching about 60 per cent. of the maximum yield, in 1893. Its present position is indicated by the statistics for 1908, which show that the total area of land cultivated in Negros Occidental and Negros Oriental was 67,740 acres, from which 65,591 tons of sugar was produced. A consideration of the figures shows that the average yield per acre throughout the island is 0·97 tons. The author of the paper has, however, seen fields so sparely sown and giving cane of such poor quality that the yield was not more than a little over a quarter of a ton per acre; while on the other hand, there are instances in the richer districts where large fields have given an average of as much as 4½ tons per acre. The fact is that the average general yield is greatly reduced through the existence of a comparatively large number of small growers who do not possess the resources, or in many cases the ability, to give their plantations proper care. The author states from his personal observations that on a well managed plantation, a few of which exist in Negros, the yield per acre under normal conditions is rarely below 1·4 tons, and is frequently nearer 1·6 tons, giving an average, between these limits, of 1½ tons.

The only variety of cane which, it appears, is grown to any large extent in Negros is called 'caña morada', or purple cane, and there is no evidence as to the time when this was introduced; although it is possible that it was imported directly at or about the time when the Recoletos commenced to occupy the island. This cane is very sensitive to changes in its surroundings, so that its composition varies much in different parts of the island; it naturally tends to form a slender, rather small plant, comparatively low in fibre and giving a juice high in sucrose and purity. The only other kinds that exist are a few fields of so-called black cane, and some scattered specimens of a white or yellow variety.

As regards the diseases of sugar-cane, the author failed to find any indications of diseased cane such as would be apparent to one who had not undergone the training of a plant pathologist. The planters recognize one insect enemy only, which they call 'bucan' or 'bugan'; this is a grub which is described as resembling the larva of the common cocoa-nut beetle, except that it is smaller. An appendix to the paper contains the results of an investigation which was undertaken by the Botanist and the Entomologist of the Bureau of Science, Manila, to discover if diseases and pests of the sugar-cane exist in Negros. The preliminary researches have shown that Philippine sugar-cane is rather remarkably free from disease. As regards Negros, the existence of red rot (*Colletotrichum falcatum*) had been reported, but careful search failed to reveal any signs of its presence. In addition, no indications were observed of the presence of root rot, caused by various fleshy fungi, rind disease, top rot, or any other fungus or bacterial disease of a serious nature; planters who were questioned on the subject supported this view of the matter. Among insects were found the cane root beetle (*Holotrichia vidua*, Sharp), the cane tip borer (*Scirpophaga intacta*, Sn ?) and the white leaf louse (*Oregma lanigera*, Zehut.). Of these, the first is the only one which does any serious damage; as many as fourteen adults three pupae and seven larvae have been taken from one hill in a field from which the cane had been harvested two months before. The remedies suggested are deep and repeated ploughing, with other vigorous cultural methods, together with the fallowing of the land for one or two years and the planting of other crops. It is mentioned that a sugar-cane pest known as the cane fulgorid (*Phenice moesta*, Westw.) has been observed in parts of the island of Luzon in the Philippines, and that its increase will make it of greater interest. It is a curious fact in regard to this insect that, although it has been reported as doing damage to certain palms in Assam and to the sycamore in Java, it does not appear to have been observed before to attack sugar-cane.

In Negros, sugar estates are owned and managed almost exclusively by Spaniards, Spanish mestizos (half-breeds), or native Visayans; few are in the hands of persons of other nationalities. Spanish is the universal language on the estates, English only being understood exceptionally. The labourers are all Visayans. The rate of wages for labour is about 6*d.* per day, with rations furnished by the estate at a cost of about 4*d*. per day, per man. There is great difficulty in obtaining labour for taking off the crop, because each planter makes his own sugar; so that a large number of labourers is required for a comparatively small portion of the year. The chief difficulties arise in the case of the small planter, who cannot afford to keep all the year round the men that he requires on his estate; for he has to obtain additional men during the harvest through the agency of contractors, to whom he often advances about £1 to £2 10*s* for each labourer required. It is unfortunately frequently the case, however, that the contractors fail to fulfil their part of the bargain, and in addition it happens fairly often that, out of twenty or thirty men who have reported for work and received a month's wages in advance, one-half has decamped within a week. The complaint is made that it is almost impossible to compel legally a man to work, even though he has been paid in advance and under a written contract. If an absconding labourer is caught, he admits the debt and expresses a willingness to return the money which he has received, as soon as an opportunity arises. He cannot be imprisoned for debt, however; so that he remains at liberty to visit other estates, and raise money on similar false pretences. The time during which this custom of advancing money has been followed makes it difficult to give it up, and the planter who attempts to do so has much difficulty in finding men to do the work for him. The practice of this form of dishonesty is increasing, and some planters state that they lose more money owing to their being victimized in this way than from all other causes, during each season.

The next portion of the report is devoted to a detailed description of the principal sugar-producing districts of Negros, with special reference to their area and production and the analysis of the soils and sugar-canes in them. The particularized nature of this information prevents an account of it from being given here, and reference is made to pages 22 to 68 of the article, if it is desired to obtain further knowledge concerning these facts. It will be well, however, to present such general matters as may be of interest, concerning the soils of the island.

THE SOILS OF NEGROS.

The following table gives the general average of the physical analysis of soils and subsoils from the chief sugar-producing districts of Negros; the figures refer to the percentages of particles of different sizes:—

	Gravel. (Larger than 1 mm.)	Coarse Sand. (1·0 to 0·5 mm.)	Medium sand. (0·5 to 0·25 mm.)	Fine sand (0·25 to 0·10 mm.)	Very fine sand. (0·10 to 0·05 mm.)	Silt. (0·05 to 0·005 mm.)	Clay. (Smaller than 0·005 mm.)
Surface soil ...	1·0	1·53	7·05	12·70	21·30	34·04	23·28
Subsoil ...	0·8	1·25	5·86	13·99	19·65	33·91	25·21

As regards the chemical constitution of the soils, the following table contains a summary, in the form of percentages, which enables the average of them to be compared with those of other countries and places, such as Hawaii, Egypt, Louisiana, Java, Demerara, Queensland and Mauritius: –

	Nitrogen.	Potash. (K_2O)	Phosphoric acid. (P_2O_5)	Lime. (CaO)	Magnesia. (MgO)	Soda. (Na_2O)
Negros	0·14	0·20	0·15	1·66	0·98	0·18
Hawaii	0·24	0·37	0·26	0·61	...	...
Egypt	0·31	1·06	0·29	4·09	2·53	1·17
Louisiana ...	0·09	0·31	0·11	0·78	0·38	0·14
Java	0·08	0·08	0·09	1·65	0·18	...
Demerara ...	...	0·11*	0·08	0·64	0·50	...
Queensland ...	...	0·20*	0·06	0·56	0·26	...
Mauritius ...	...	0·17	0·15	0·36	...	...

The results are stated to show that from a general point of view the soils of Negros contain a moderate proportion of lime, together with ample amounts of potash, phosphoric acid and nitrogen for profitable sugar-growing. The soil may be regarded as fine in texture, for all but a small percentage will pass through a 1 mm. sieve. The general conclusion is reached in the article that, although it is not notably rich in most constituents, 'the soil of Negros may rightfully be classed as among the better of the sugar lands of the world, and, given the proper care and cultivation, should be able to yield eventually as much sugar in proportion to the area of ground planted as any other country depending for its supply of water on its natural rainfall.'

As far as the manurial treatment of the soil is concerned, no attention is given to this at present by most of the planters in Negros. It is true, nevertheless, that lessening yields in some of the districts where the soil is of only average fertility are causing some attempts to be made toward its improvement. These consist in fencing off the poorest land for a season, and using it as a pen for stock. There is beginning to be a recognition, also, of the manurial value of scums and megass ashes; although the latter have still a far greater application as a means for improving the state of the yard and the roads near the sugar house. Lime is employed to a very limited extent, and uncertainty exists as to its real use; a planter in Negros has been known to have the idea that its application to the soil will effect a saving in the amount to be used later in the sugar house—a circumstance which throws an illuminating light on the ignorance which commonly exists in regard to the simplest facts of agricultural science.

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*Including soda.

Consideration is given to the mineral content of the cane, and it is shown that, judging from analyses of megass ash, this is low—a result that might be predicted from the low fibre content. A short general review of the matter, in relation to the manurial requirements of the cane leads to the following conclusion : 'that the question of the extent to which fertilizers may profitably be employed on the soils of Negros, or of any other sugar-producing country, is largely one of book-keeping, rather than of chemistry and can be determined for a given locality only by actual field experiments in that locality, and by the profit-and-loss accounts of the plantations on which these experiments are made.' The extent to which this conclusion is supported by experience in the West Indies does not require any particular indication here.

THE SUGAR-CANE OF NEGROS.

Particulars are given of the average composition of the purple or native cane in Negros, and there are quoted for comparison facts concerning sugar-cane from the West Indies, Egypt, Java, Hawaii and Louisiana ; in the first case, that of Negros, the averages are computed from observations made in four of the chief sugar-producing districts of the island. Particulars regarding other varieties of cane grown in Negros are given as well ; but they are of little interest in the present connexion. In the following table, the facts relating to the comparison of the averages for Negros cane with those of others mentioned are summarized :—

	In the cane.		In the juice.			
	Sucrose, per cent.	Fibre, per cent.	Brix.	Sucrose, per cent.	Purity.	Glucose, per cent.
Negros ..	16·06	10·02	20·35	18·40	90·38	0·71
West Indies*	14·39	15·07	20·58	18·51	89·09	0·93
Egypt† .	14·50	..	19·20	16·88	87·90	0·18
Java‡ ...	12·30	12·01	...	..	83·74	.
Hawaii‖ ..	15·91	12·50	..	...	...	...
Louisiana ...	..	..	15·00	11·78	78·53	1·56

*Cane and first mill juice at the Antigua Sugar Factory. (Watts.)
†Exceptionally good season. (Tiemann.)
‡Results from 107 factories, in 1908. (Geerligs.)
‖Irrigated cane.

As is pointed out, West Indian sugar-cane is comparable with that of Negros in regard to the sugar content and purity of the juice; but it is stated that it would not meet with much favour in that island, on account of its comparatively high fibre content.

In a more general way, the conclusion is reached that the cane ordinarily grown in Negros yields a juice whose richness and purity are as high as that of the cane of almost any other sugar-producing country; and there is the additional useful quality that it possesses, of having a low fibre content, lending readily to its employment for economical extraction in the mill. It is not forgotten, however, that the possession of such a cane should not prevent attempts from being made to introduce better varieties, particularly in consideration of the fact that these show a power to adapt themselves to a new environment, so that the following of such a policy may lead eventually to the possession by Negros of several varieties showing a marked superiority to that which is fulfilling its purpose so well at present.

SUGAR-CANE CULTIVATION IN NEGROS.

The first step in the preparation of the soil on the sugar estates, after the cane has been reaped, is to burn the trash that is left, as soon as the weather will permit of this. It is evident that the advantages of such a procedure are the easy removal of the trash, the quick preparation of the land for ploughing, the destruction of injurious insects, and the freeing of the potash and phosphoric acid in the trash in a readily available condition for the succeeding plants. There is, however, the well recognized disadvantage that humus—so important in soils in the tropics—is lost, together with the nitrogen that it contains.

After burning, that is usually between November and April, land from which a succeeding crop is to be obtained is given a preliminary ploughing, and this is done from twice to six times before planting. This ploughing is commenced earlier in the case of fields that have remained fallow from the previous year, and may be undertaken as early as July or August, in order that the land shall be ready for the next planting.

The ploughs used are an old-style native, wooden implement, which is drawn by the carabao, or water buffalo. From the figures given concerning the labour needed, it would appear that four men, four ploughs, and eight buffalos are required for 1 acre of land per day, allowing of course for the nature of the soil and for weather conditions. Less labour is needed for the ploughings that come after this. After being ploughed, the ground is harrowed, and laid out in rows 2 ft. 6 inches to 5 feet apart, the earth in the rows being dragged to a height of about 6 inches.

For planting, only the white tops of the cane are employed; they are removed either while the cane is still standing or after it has been cut. Each piece is from 8 to 10 inches long; in dry weather, before they are planted, they are soaked in water for one to three days before being set out. The preparation of these is mostly done by women and children, who are paid by contract for each 10,000 tops.

More detailed information concerning the methods of planting shows that the rows are usually made with about 3 feet between them, and the cuttings are placed in them about 16 inches apart in the rows, taking the distances from similar points; thus nearly 10,000 plants are required per acre. The usual method of planting is to thrust the cane tops into the ground in a slanting direction, at the bottom of the furrows, and then to pack loose soil around them, so that a length of an inch or two is left projecting above the surface. The general rule is for the work to be performed by men, each accompanied by a boy who carries the plants; sometimes, however, the work of planting the cane, as well as of preparing it, is done by women and children. It is of some interest that, particularly in dry years and toward the end of the season, two tops are sometimes planted in the place of one, to ensure the possession of one plant in each hole, the distance between the rows and in the rows being correspondingly increased, so that the number of plants per acre rarely exceeds 12,000. A different method is often employed on the east coast of Negros, where droughts sometimes occur, the cane being planted in a slanting hole about 16 inches deep, which has been made by a sharpened stick, frequently pointed with iron.

AFTER-CULTIVATION OF THE SUGAR-CANE.

The existence of varying conditions throughout the island naturally causes several methods of after-cultivation to be in vogue. A procedure that may be taken to be fairly representative of the general system is as follows. When the cane has been in the ground for four or five weeks, and the plants have reached a height of 1 foot to 16 inches, two furrows are ploughed close to the cane in each row, the soil being thrown away from the cane and between the rows. Next, by means of the hoe a space around each plant is cleared of weeds and of the loose soil moved by the plough. Where the cane is planted in squares, the hoe is not used, but a similar effect is obtained by ploughing two furrows between the rows in either direction. If weeds spring up, the operation is repeated fifteen or twenty days later. Until the month of May or June, or when the first rains are received, nothing is done except an occasional ploughing or harrowing. When the time arrives, three furrows are made between the rows, so that soil is thrown up to the roots of the cane and a shallow trench is made between the rows; the purpose of this process is the opposite of that of the former: it prevents water from standing near the cane and causing damage. It sometimes happens that a considerable period of dry weather comes after the first rains, and it is then necessary to repeat the first process. As soon as the rainy season actually sets in, generally in July, the canes are again moulded up; these should be, by this time, about 6 feet high. In this moulding up, four furrows instead of three are made between the rows; the soil is packed to a greater height; and deeper trenches are left between the rows. A further process is sometimes adopted, which consists in banking up the earth along the rows and at each end, with a spade, and levelling irregularities in the soil between the cane, so that there may be no chance for water to collect around it; this process is considered, however, to be more ornamental than useful. In any case, all after-cultivation now ceases, and the cane is left to attain its final development without assistance.

The processes that have just been described are undertaken in the case of plant cane only. Ratooning is common in Negros, the total number of crops without replanting being from two to eight. The number of times to ratoon is decided chiefly by financial considerations; but although the fact that with ratoons planting has not to be undertaken again results in the saving of time and expense, there are the disadvantages that the yield becomes smaller year by year. This is partly because of the shorter time that the cane is allowed to ripen, on account of the fact that the extensive rains make it necessary to cut the cane every year; and partly because the spread of the ratoons causes the rows to become irregular in the course of time, thus preventing proper tillage, with the consequent stunting of growth of the plants. In the cultivation of ratoons, after the fields have been burnt, the land is subjected to the process described first above. For four to six weeks afterward, the only cultivation is sufficient ploughing or hoeing to keep down weeds; then the young canes are moulded up by means of the plough, and treated subsequently much in the same way as plant canes.

As regards yields from the different crops, the data that the author has been able to gather show that, under the conditions of the ordinary method of sugar manufacture in Negros, the following yields are most usually obtained in the more fertile districts: plant cane 2·3 tons per acre, first ratoons 1·8 tons, second ratoons 1·6 tons, third ratoons 1·4 tons, fourth ratoons 1·1 tons per acre. In cases where the yield of cane is such as to give less than about ¾-ton of sugar per acre, the plants are considered to be hardly worth the cutting.

The period of growth of the cane varies much with the special conditions, the average time being eleven to twelve months, between the limits of nine and fourteen. The fact that each plantation manufactures its own sugar makes the time of cutting depend much on whether the cane is required or not at the mill. The cultivation of the crop year after year in the same fields, without change, tends naturally to shorten the time of growth, and this is also lessened for the next crop when an exceptionally long rainy season delays grinding for a month or two; there is the additional circumstance that late planted cane may be cut before its time, because of the occurrence of a prolonged dry period toward the end of the season.

COST OF CANE CULTIVATION.

In estimates which are based on the general conditions throughout Negros in circumstances of average efficiency, the approximate cost of planting and cultivating 1 acre of land from burning to cutting, with no charge for work animals, implements or supervision is given at £1 19*s.* per acre, the cost of labour being taken at 10*d.* per day. This figure refers to plant cane only; for ratoons, making the same allowances and at the same price for labour, the estimate is given as £1 0*s.* 8*d.* per acre. Such land, cultivated in the way that has been described, may be expected to give about 1·35 tons of sugar per acre, counting plants and ratoons; and it is shown that the average amount spent in wages and the maintenance of labourers in connexion with cultivation works out at £1 2*s.* per ton of sugar produced.

CUTTING AND TRANSPORT OF CANE.

As has been indicated, the tops are often removed from the canes while they are standing; this is when they are required immediately for planting. With reference to the harvesting of the cane itself, enough of this is sometimes cut, during a temporary stoppage of the mill, to give several days' supply. This procedure is likely to cause serious losses, particularly where the delay is longer than was expected at first, and the author gives an instance where he saw cane of good appearance being crushed, which was yielding a sugar polarizing at 68·6°, with 17·4 glucose; while the juice from the mill gave: Brix 20·86, sucrose 16·18, purity 77·6, glucose 2·76. The reason for these results was understood when it was learned that this cane had been topped ten days before, and had been kept for five days after cutting, on account of an accident to the mill.

The transport of the cane to the mill is effected by various means, among which are light portable tramways, mostly of English, German, or Belgian make; systems with semi-portable tracks for the main line, with branches into the fields; light four-wheeled wagons holding about 2 tons of cane and drawn by two animals; and the primitive two-wheeled buffalo cart. On one estate, a steam traction engine is sometimes used. All loading and unloading of the cane is done by hand. The cars employed are of iron, with wooden bottoms, holding about 1 ton of cane and being drawn mostly generally by Chinese bullocks, less frequently by the buffalo.

The average cost of cutting the cane is about 6*s.* per ton of sugar produced. This naturally varies with the characteristics of the cane, the labour conditions, and the reputation possessed by the planter for requiring thorough work.

THE MANUFACTURE OF SUGAR.

The sugar mills in Negros are driven by steam, by water-power, or by buffalos or oxen. The first method is most generally employed; the water-power mills are almost all found on small estates in certain parts of the interior, where small mountain streams exist which furnish sufficient power to grind from 30 to 60 tons per day. The mills worked by animals are rapidly disappearing. Dealing more particularly with the first kind, these are stated to be practically all of English or Scotch origin, and are of the ordinary three-roller type driven directly from a single cylinder engine under 40 to 80 ℔. pressure, with a nominal average horse-power of eight to ten. A consideration of the matter is given which shows that an average mill may be said to be capable of dealing daily with 4½ to 5½ tons of sugar, or about 50 to 60 tons of cane. The cane is fed to the mill by hand, from heaps on the ground. In some cases mechanical carriers are used, but as considerable care is required in placing the cane on these and in working them, they appear to save very little time, and their adoption does not lead to much reduction in the number of labourers required.

The fuel consists mainly of megass, and under good conditions of weather and working, the amount of this is generally sufficient for the supply of all that is required, together with the provision of a surplus to be used when this is wanted. The megass from the mill is picked over by two labourers who do nothing else, and any pieces that have not been properly crushed are fed again into it. In relation to its use as fuel, as the fresh megass contains about 55 per cent. of water, it has to be dried before it can be burned, and for this purpose it is carried in baskets or cradles of rattan, which are slung from bamboo poles, to the mill yard, where it is spread out during the day, and raked over from time to time in order to make it dry quickly. Further treatment consists in raking it up at night, and then spreading it out again, the next morning, for a few hours; it is then dry enough to be used in the furnaces at once, or to be stored in the megass sheds. Statements are made in connexion with the use of megass in the furnaces which serve as a reminder of the conditions in parts of the West Indies where, in rainy weather, it has to be supplied from the storehouse, while that which is being produced cannot be dried.

In considering the efficiency of the mills used in Negros, the conclusion is reached that the best means of ascertaining losses at the mill quickly and with accuracy, where there is no chemical control, is by determining the factor 'mill juice in megass per 100 fibre' (see *West Indian Bulletin*, Vols. IX, p. 85, X, p. 107, and the article which follows this). As might be expected, widely varying results were actually obtained in the investigation. It was found that, on an average, 178·5 parts of mill juice are lost in the megass for every 100 parts of fibre in megass, which corresponds to an actual lost of the same amount of mill juice for every 100 parts of fibre in the cane, because all the fibre in the cane is finally removed as megass. It is pointed out that this figure corresponds to what is given by Dr. Francis Watts as the working of a fair single mill. Using these results further, it is shown that the percentage extraction of juice on the cane would be 69·4 out of a possible 87·3; so that the percentage of total juice lost in milling would be 20·5.

A reason is adduced for the fact that it is very doubtful if the work in actual practice is as good as this, namely the circumstance that the cane fed to the mill is almost certain to be mixed with trash and adhering leaves, with the result that the wetting of this additional material with juice, which necessarily takes place, leads to a direct loss. Making an allowance for this matter and combining it with the figures that have been obtained already, the conclusion is reached that the average loss of sugar in the megass, in Negros, is about 25 per cent. of the whole of the sugar in the cane. The proportion naturally depends on the kind of cane that is being used : when this is very soft and tender it may be as low as 20 per cent., and with very fibrous cane as high as 33 per cent. The average extraction, on the weight of the cane, is about 64·5 per cent., between the limits of 50 and 70 per cent.—a result which, as is pointed out, is rather better than those obtained in most countries where sugar is produced by primitive methods, as in the West Indies. This superiority is not attributed, however, to any greater efficiency of the mills in Negros, but solely to the greater suitability, for milling, of the cane in the latter place.

Concrete sugar is the kind produced solely in the island. The plant for the manufacture of this from the juice is comprised of five or six hemispherical iron vessels, in which are conducted all the operations of clarification, evaporation, and boiling to a concrete. These vessels are from 40 to 80 inches in internal diameter, the measurements being taken from a short distance below the top, where the rim forms a lip. They are built into a brick or stone furnace, with the rims projecting, in such a way that they extend in a line from the place where the juice enters the boiling house to that where it is boiled to a strike ; as is usually the case, the largest pan comes first and the smaller ones are successively raised slightly above the larger. Two methods are employed for preventing the juice from being lost by boiling over : one is to enclose the series, at the top, by means of a brick or cement wall 16 or 20 inches high, or to attach an additional thin iron rim to the top of each pan. The most customary arrangement in the sugar-house is to have two series of four pans, each series being fed from a common largest pan receiving the juice. As in the West Indies, the smallest pan, in which the sugar is boiled to a strike, is nearest to the furnace door. Each series may be used alternately, and the heat that passes from the sugar-boiling may be employed for raising the steam required to work the mill.

The juice, after being strained, passes into the fifth pan (reckoning the strike pan as the first), where it attains a temperature of 160° or 180° F., and part of the impurities is removed by skimming off the froth which rises, the skimmings being thrown into scum tanks on either side. As it is needed, juice is ladled, by means of a kerosene tin fixed to the end of a wooden pole, to the next smaller pans, which are kept so nearly full that the scums rising in them will flow back into the fifth pan.

As far as the matter of liming is concerned, the juice is usually about half neutralized in the fourth pan, and the process is completed in No. 3, where active boiling first takes place; where a filter press is used, hot juice from the fourth pan is allowed to settle and is then poured off into No. 3; it is these settlings that are sometimes further treated in the filter press to be described later. Liming is sometimes commenced in the fifth pan, and if there is any doubt if a sufficient amount is being added, the man in charge will sometimes even add a little at the time to the juice as far as the second pan, or very rarely, even in the strike pan. This work is always conducted by the chief sugar boiler, who has had many years' experience of it, and in consequence sometimes commands wages at the rate of 2s. a day. The point of neutralization is decided by experience arising from long practice, and it is an interesting fact that, as the author states, litmus paper is still a decided curiosity in Negros; at the time of writing, not one sugar maker in the whole island was known who employed regularly either this or any other indicator for the purpose of ascertaining when the juice is neutral.

The tendency is to underlime rather than to overlime the juice, because in this way the sugar obtained is brighter in colour, though less clean, than when an excess of lime is used. In the process of clarification, the impurities in the juice boiling in the third pan rise to the surface and overflow into the fourth and fifth, whence they are removed by skimming and thrown into the scum tank. Clarification continues actually as far as the second pan, from which the juice overflows continually into the third, and is being constantly ladled back. The lime employed is obtained from a neighbouring island, and is of exceedingly bad quality on account of carelessness in slaking (sea-water, even, being sometimes used for the purpose), and because it is stored and shipped either in bulk or in bags made from the leaf of a plant called 'buri', so that by the time it is used in the sugar house it has been converted mostly into chalk, which is of very little use for the purpose of clarification.

In boiling the juice to a concrete, when a strike has been removed from the last pan, this is filled again as quickly as possible with juice from the second; such juice has become fairly clear by this time, and has reached about 50° Brix. At the same time, fresh fuel is placed in the furnaces, and as the juice evaporates, more of this is added from the second pan, into which any remaining impurities that rise to the surface are removed. When it is considered by the chief sugar boiler that there is sufficient juice in the pan. the whole of this is boiled down as quickly as possible until, on taking a sample with a stick, it is seen that a strike may be made. When this occurs, the fires are drawn, and the massecuite is poured into wooden trays and stirred with a spade during crystallization.

The estimation of losses during the manufacture of sugar in Negros is a matter of comparative simplicity, because no molasses is produced, as the clarified juice is always boiled to a concrete. Such a condition would make factory control in the island comparatively simple, except for the fact that the canes are never weighed, nor is there any knowledge concerning the weight or volume of juice that is dealt with in the sugar house. The chief causes of loss are: (1) the inclusion of sucrose in the skimmings, settlings and the filter press mud; (2) inversion through long boiling at atmospheric pressure; (3) caramelization and subsequent destruction of sucrose; (4) careless handling of the juice and massecuite during the process, together with theft by the workmen. Details as to these losses show that the percentage of sucrose in the scums, which are thrown away, is always very high; while the straining of the juice free from floating impurities before it reaches the first pan causes a certain loss of sucrose, because there is no arrangement by which the juice may be pressed out of these. In addition, the skimmings from the fifth pan contain about 23 per cent. of sucrose. A similar amount of sugar is present in the filter press mud; this is composed of settlings from the vessel in which hot juice from pan No. 4 is poured, the procedure being to place the settlings into sacks on which old pieces of iron and car wheels are put, for the purpose of producing pressure—a primitive kind of filter press being thus constituted.

As these skimmings and the filter press mud are thrown away, some idea may be gained of the loss that takes place in the manipulation connected with this part of the manufacture. It is mentioned that a few factories in Negros show better working than this; nevertheless the instances that are just given refer to conditions above the average, as the scums and settlings from many factories are allowed to run to waste directly.

Two or three fairly modern steam-heated filter presses actually exist in the island; but they are not regarded as being entirely satisfactory, mainly because the conditions of labour do not permit of their being worked in an intelligent manner.

THE QUALITY OF SUGAR PRODUCED.

The sugar sold in the Iloilo market is classified as follows:—

Superior:—

No. 1, 87° to 89°, or higher—average 88°.
No. 2, 85° to 87°.
No. 3, 80° to 85°.

Wet:—

Humedo, 76° to 80°.
Corriente, 70° to 76°.

The difference in price has been generally 0·045*d.* per lb., or 8*s.* 5*d.* per ton; but as nearly all the Superior sugar is now being bought for New York, this relation of prices between the grades holds no longer. On the New York basis of 0·1 c. gold per lb. for each degree in polarization, the difference between Nos. 1 and 2 would be 0·101*d.* per lb., or 18*s.* 10*d.* per ton, and between Nos. 2 and 3, 0·176*d.* per lb., or £1 12*s.* 10*d.* per ton. In large quantities, Superior is sold on an arbitrary basis, once supposed to represent the average proportions of the different kinds produced, namely No. 1—one-eighth (12·5 per cent.), No. 2—one-quarter (25 per cent.), No. 3—five-eigths (62·5 per cent.), the price for assorted (polarization 84°) being between those of the last two. At the present time, the proportions are more nearly 26, 18 and 56 per cent., respectively, with polarization 84·4°. The usual quotation for Humedo is about 0·18*d.* per lb., or £1 13*s.* 7*d.* per ton less than for No. 3, while there is no fixed relationship to the other grades, with respect to Corriente. These two low grade sugars are largely mixed together and sold as wet sugar, without any regard to the polarization; the better kinds of Humedo are, however, frequently disposed of by mixing them in small quantities with Superior No. 3. The production of such sugar is between 10 and 20 per cent. of the total. Taking all grades into consideration, the average quality of the sugar made in Negros from year to year may be concluded to be about 85 per cent. of Superior No. 3, and 15 per cent. of Humedo polarizing 75°, the average polarization of the whole being 82·6°.

In relation to the composition of the mill juice and the quality of the sugar made by it, the following are the averages of results obtained for 30 mills in the island:—

Mill juice	Brix	19·71
	Sucrose	17·20
	Purity	87·03
	Glucose	1·20
Sugar made	Polarization	82·0
	Glucose	8·9
Glucose, percentage on sucrose	In the juice	7·4
	In the sugar	11·4

It is a curious circumstance that in Negros, although many planters exercise the greatest care and thought in regard to the field operations connected with the product obtained, there is rarely any attention by them to the acquisition of knowledge in connexion with the manufacture of sugar, either for the purposes of the daily procedure or with the object of devising and adopting improvements. The quality of the sugar produced depends, certainly, to some extent on that of the cane raised, but it is affected in a much larger and more important degree by the skill and faithfulness of a native sugar boiler, who as has been stated, is rarely paid at the rate of more than two shillings per day. The extent to which this neglect exists of the details and procedure of the manufacture of sugar is illustrated by the statement that not one planter in twenty is capable of superintending the tempering and clarification of the juice, and of determining the point at which a strike must be made, if the best quality of sugar is to be obtained.

THE COST OF SUGAR MANUFACTURE.

A detailed estimate is given of the approximate daily cost of operating a sugar works in Negros producing 4½ tons of sugar per day of fourteen hours, no account being taken of the cost of supervision, depreciation of the plant or interest on capital; this works out at £5 5s., or £1 3s. 4*d.* per ton of sugar.

THE TRANSPORTATION AND SALE OF SUGAR.

After the sugar has been manufactured and packed, the planter in Negros is faced with further difficulties and expense, for he has to bring it to the sea coast or the nearest river, undertake the loading, and make arrangements for it to be received and sold at Iloilo. Where the plantations are situated near the sea or a navigable river, loading costs only about 4½*d.* to 9*d.* per ton. Inland planters are reduced to the necessity of bringing the sugar down in quantities of a few tons at a time, in carts drawn by buffalos over roads that are often very bad; the extreme cost of this method of transport is as much as 11*s*. per ton. On an average, the probable cost is 8*s*. 8*d*. per ton. Carriage to Iloilo is effected in small, flat-bottomed schooners (called lorchas), which are specially built for the work, and possess a very light draft, with a capacity of 100 tons or less. The cost of carriage varies according, to distance, being between 6*s*. 6*d*. and 11*s*., and averaging 7*s*. 4*d*. per ton. After it reaches Iloilo, the planters' agents become responsible for the sugar, and arrange for its discharging, weighing, classification, repacking, and sale or storage. An estimate is given of the cost of shipping the sugar to Iloilo and effecting the sales; this amounts to about £1 per ton.

THE RELATION BETWEEN THE WEIGHT OF CANE AND THE WEIGHT OF SUGAR PRODUCED.

Details are given of work which was undertaken for the purpose of finding the weight of sugar that is usually obtained from a given weight of cane in Negros. For the purpose, experiments were carried out on two estates, using cane of the same kind but of a different age in each case. It was found that with a poor juice, much less sucrose is lost in the skimmings than when a richer one is being worked up; the reason is that the lower density of the former allows impurities to settle more quickly, and there is naturally a smaller loss in the skimmings. The loss by inversion appeared to be about the same in both cases; but in making sugar from the poorer juice, the destruction of sugar by inversion, caramelization and burning was very much greater. The total losses in manufacture were 1 per cent. more in the case of the poor cane than in that of the better kind. The apparent amount of raw sugar from the poorer juice was somewhat less than that from the other, but not as much less as might be expected, because the diminution in the actual sugar content is largely made up for through the greater amount of impurities contained in the sugar. The inferior cane yielded 0·94 tons of Corriente sugar per ton of cane; this gives 10·61 tons of cane per ton of sugar.

Considering all the results that were obtained in the experiments, it is shown that the average losses of sucrose during the manufacture of sugar in Negros, expressed as percentages of the total sucrose in the cane, are approximately as follows:—

In the megass	25·0
In the skimmings (no filter press used)	5 0
By inversion (including apparent losses)	2·5
Burned and lost accidentally and through theft	10·0
'Shrinkage' in transit to Iloilo, including tare ...	1·5
Total	44·0

This estimate gives a recovery of raw sugar of 56 per cent.; the yield in sucrose on cane is therefore 8·2 per cent., so that as the average sugar in the island contains 82 per cent. of sucrose, 1 ton of cane gives about 0·1 ton of raw sugar. There is little variation in this figure throughout the island, as the quality of the sugar, rather than the quantity, is affected by the kind of cane that is ground.

all, so to speak, working on their own and everybody in them working on his own, you cannot hope for the results which you may achieve under a proper system of co-operation, and I should like to see, therefore, grafted on this Department some agency of the kind which in this country is represented by the Agricultural Organization Society, in order to secure for the smaller producers the advantages of big producers. There is no place where it is harder to overcome the prejudices against co-operation than in the West Indies, and one can only hope that in course of time they may come to see the advantages of working closer together. I am glad to testify to the intense value to me, as a sugar planter, of the discoveries made with regard to cane culture and seedling canes, and I hope that, now that the Imperial Government has agreed to continue to find money for the maintenance of the central Department, we may see still greater results in the course of the next ten years.

Mr. **FORSTER M. ALLEYNE** (Barbados): I was in Barbados during the whole time Sir Daniel Morris was head of the Imperial Department of Agriculture, and so have an intimate knowledge of his work; in fact, some of the experiments he conducted were made on my own family estates. I am not an old man yet, but I remember the time when science, as regards cane planting, was sniffed at by managers and others, especially in Barbados. Of course, before Sir Daniel Morris arrived certain experiments had been made with seedlings, but with the advent of the Imperial Department a prestige was given to this work which it had not possessed before. Now our planters run to the Department, examine the statistics of experiments and plant accordingly; in fact, the whole atmosphere is changed, and I think that alone will be a monument to the work of Sir Daniel Morris in the West Indies. We owe him, especially in Barbados, most cordial thanks for the work he has done, and in this connexion I would mention specially his excellent A B C books, which have been the means of laying foundations of knowledge which cannot fail to be lasting.

Mr. **DU BUISSON**: As the lecturer has told us, the name of Dr. Watts, the new Imperial Commissioner of Agriculture, will be closely associated with the success of the central factories in the Leeward Islands. The scheme has worked exceedingly well, and the factory at Antigua is now capable of turning out double the quantity of sugar that was originally contemplated. It is an immense advantage to the proprietors of estates to be able to consult the officers of the Department on the everyday work of the plantations, and these officers give their advice readily and freely. It would be an immense misfortune to the West Indies if this Department were ever to be given up.

The **CHAIRMAN** (The Right Hon. Lord Brassey, G.C.B.): It is quite unnecessary to enlarge on the immense importance to this country of its tropical possessions, without which, indeed, these islands would not hold the place they do among the nations of the world. Among these tropical possessions the West Indies are not the least important; they are certainly not the least, also, in the charm of their natural scenery. Those who have cruised in those waters—I have made several voyages to the

West Indies—will have an undying recollection of those gems of beauty set in the broad waters of the Atlantic. It has been rather sad to know in these later years that the prosperity which these islands formerly enjoyed has been seriously threatened. To-day we are glad to hear that there is a revival of their former prosperity. That is due to several causes. The cultivation of sugar is no longer exposed to the unfair competition of beet sugar grown with the aid of lavish bounties. It is also due to the introduction of better methods of cultivation, and of several new kinds of cultivation. It is satisfactory and interesting to have the testimony given to us by competent speakers to the admirable - indeed, the essential —work which has been done by the Imperial Department of Agriculture. It is well, therefore, we should have the opportunity afforded us this evening of paying a well merited tribute to those concerned in this valuable work, among whom Sir Daniel Morris is not the least meritorious. We desire to express gratitude to him and his colleagues for what they have done. One word with regard to that fine Imperial establishment at Kew. It has been the parent of many valuable efforts throughout the length and breadth of the Empire. It was exceedingly interesting to hear the extract on Jamaica cigars read from Sir Joseph Hooker, now in his ninety-fourth year, I think, and we desire to pay a tribute not only to him but to his successor, Sir W. Thiselton-Dyer. The Royal Colonial Institute is valuable in many ways, and, not least, in affording opportunities such as the present for obtaining information not only from scientific men, but from those gallant fellows, the Governors of the Colonies, and others who carry on the work of the Empire in distant parts.

Sir DANIEL MORRIS, K.C.M.G.: I desire to thank you for the manner in which you have received my paper, and also to thank those who have been kind enough to bear testimony to the work of the Department. Although I stand here as the representative of the Department, I do so simply because of the absence of those who have so nobly assisted in the work. I join heartily in expressing our indebtedness to the Institute for the opportunities offered by it for discussing Colonial questions. I am informed this is the twenty-first paper read in reference to West Indian subjects, so that the West Indies may be said to have attained their majority in the records of the Royal Colonial Institute. The Institute has always had on its Council at least one representative for the West Indies. For many years Sir Nevile Lubbock acted in that capacity and rendered valuable service. He is now a Vice-President. I consider it a great honour to be invited to join the Council in succession to Sir Nevile Lubbock, and I shall be glad to render any service in my power.

WHAT SCIENCE HAS DONE FOR THE WEST INDIES.*

BY SIR W. T. THISELTON-DYER, K.C.M.G., F.R.S., ETC.

A little more than a year ago I told in these pages, with a very sore heart, the story of what the late Sir Alfred Jones had accomplished for the West Indies by enlightened commercial methods. That chapter is unhappily closed, for no one has succeeded him. It is a more hopeful task which is now imposed upon me—to give some account of what science has done, and will continue to do. It is worth the telling, and it is more than a mere record of success, but carries a moral of far-reaching extent.

This journal, from its first number, has never ceased to preach the necessity of applying knowledge to the right conduct of human affairs. It continues to preach, and in face of the stolid conservatism of our methods, one might in a despondent mood think with little effect. But if one looks back over long periods it is not so, and the change in public opinion as represented by governmental action is little short of astonishing.

When I first became engaged in colonial work some forty years ago, the doctrine of *laissez faire* was in full swing. It was held that self-interest would determine whether an industry would succeed or fail; if it failed it deserved to do so, and another would take its place. In either case it was best to leave it severely alone. This is not the place to discuss how far such a doctrine is sound. But practically it is continually being abandoned. No industry is now free from governmental interference, and such interference is only tolerable if directed by adequate technical knowledge. Interference must always be of the nature of restraint, and at any rate theoretically one may ask whether some compensation is not justified. It can hardly be doubted that the community will have more and more to provide knowledge for industry of the kind that self-interest is powerless to provide for itself.

Mill, however, and other economists clearly saw that academic economic principles were not universally applicable to agriculture. The reason is obvious: the soil is not removable, but has to be utilized as best it can, and where it is. If it went generally out of cultivation food would fail. It was still, however, left to *laissez faire*, except in some measure in India, where the Government undertook the pioneering work in regard to tea, cinchona, rubber, and some other staples, and then left their commercial development to private individuals. In any other country but our own the work of Rothamsted would have been promoted by the State. There are undoubtedly advantages in scientific research being left unfettered to individual effort, but it is only the richest landowners, such as Coke of Holkham, and the Dukes of Bedford, who can afford to add to agricultural

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knowledge by experiment. The average cultivator is powerless to follow other than traditional methods. Yet it is in the interest of the community that he should do better in order that the maximum return may be obtained from the land.

When this country began to acquire tropical possessions, it was seen, however, that something more than *laissez faire* was required for their economic development. It was the Royal Society, at the hands of its president, Sir Joseph Banks, who first took the work in hand. Having the ear of the King, he was able to use Kew, which was then the private property of the Royal Family, for the purpose. The mutiny of the *Bounty* was an incident in an attempt to add to the cultural resources of the West Indies. An indirect result was the foundation of the great Dutch colonial botanical establishment at Buitenzorg. When it was decided that Kew should be maintained as a national establishment, its colonial utility was appearently one of the main reasons for the decision. In a scheme which received the sanction of Parliament the interest of 'commerce' and 'agriculture' were recognized, as well as the supply 'of authentic and official information on points connected with the foundation of new colonies.' Its functions in this respect were steadily fostered by the Hookers, father and son. The history of Kew thus affords one of the earliest instances in this country of the recognition of the duty of the State to promote scientific knowledge in the public interest. And the historic meaning of the controversies which have occasionally brought Kew prominently into public notice is simply the attempt of a policy of *laissez faire* to arrest its work.

But anything which is rooted in sound principles cannot be checked, because their necessity insists on asserting itself; and the West Indies again supply the illustration. Obviously their chief assets is solar energy. Our channel islands supply us with early vegetables. In a rule-of-three sum the West Indies stand for the channel islands of the North Atlantic shores. Alfred Jones saw this and started a line of steamers to flood us with West Indian fruit. But this is anticipating. In the 'nineties' their condition was the reverse of prosperous. And, if it is a paradox that science was indirectly the cause of the mischief, it happily was able to supply the remedy.

The Napoleonic empire left behind it two permanent legacies—the French code and beetroot sugar. When Napoleon's continental system closed the ports of Europe to British colonial produce, the import of tropical sugar was cut off. As sugar is a necessity of modern food there was the strongest impulse to find a new supply. I need not repeat a well-worn story. The Chemist and the cultivator lavished all their resources on the unpromising beet, and ultimately dethroned the sugar-cane. Then came the bounties which flooded this country with sugar at scarcely more than cost price, and drove cane sugar out of consumption.

There is a fundamental principle in agriculture: never to trust to a single crop. Ireland trusted to the potato and Ceylon to coffee, and both failed them; this was from disease. The West Indies trusted to sugar, and in their case the ruin was economic. The balance of solar energy being in its favour, on equal terms the cane should at least hold its own with the beet. But now comes the mistake and its moral. The sugar content of the cane was held to be incapable of increase; the methods of manufacture were often archaic and wasteful. Beetroot sugar was the product of the most refined scientific skill in both directions. It was the fable of the hare and the tortoise.

In the 'nineties then the West Indies had sunk from prosperity to poverty. I heard it publicly stated at a meeting in the city of London that annexation to the United States was the only remedy. On some of the islands the peasantry were clamouring for food. And so things might have remained but for Mr. Chamberlain, who has never hesitated to cut himself adrift from hide-bound prejudices, and regardless of them, to apply a practical remedy to an evil.

In 1897, after obtaining from Parliament some temporary relief, he sent out a commission of inquiry, of which Sir Edward Grey was a member, and to which Sir Daniel Morris, then assistant director of Kew, was attached as secretary. The Imperial Department of Agriculture was established the following year, and Sir Daniel Morris left Kew to take up the duties of Commissioner. In a recent paper before the Royal Colonial Institute (see *Nature*, January 26) he has given a full, and I think extremely modest, account of what he was able to achieve. That paper will speak for itself. My purpose is to show how success flowed from the patient and persistent application of scientific method.

The first thing was to see if the sugar content of the cane could be improved. Like many other plants subjected to long cultivation, it was believed to have lost the power of producing seeds. The Pacific Islands had been ransacked without much success to find more productive kinds which might have arisen possibly by bud variation. The White Transparent cane, which is regarded as a standard in the West Indies, yields 2¼ tons of sugar to the acre. As sugar content varies, like everything else, in individual plants, it was suggested from Kew that an improved race might be obtained by the process of chemical selection by which the Vilmorins worked up the beet to a high standard and maintained it at it. Some success was obtained, but it was evident that it would be extremely slow. By a stroke of good fortune a more rapid method was discovered. About 1888, Mr. Bovell and Professor Harrison noticed the spontaneous occurrence of seedling sugar-canes in Barbados. It was found that the sugar-cane did actually produce seed, though in so small a quantity that it had been overlooked. As this at once opened the door to seminal variation and selection, the attention of the Colonial Office was at once directed by Kew to the importance of the discovery. The work was vigorously taken up by Sir Daniel Morris, and from 1908* onwards seedlings have been raised on a large scale by Mr. Bovell, and continuously selected from, as well as hybridized.

The result has surpassed expectation. One seedling cane, for example, B. 3405, gave an increase more than the standard

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*1898.—Ed. *W.I.B.*

of 1 ton an acre, representing a net profit of £8. Dr. Watts, the present Commissioner, estimates that the benefit to Antigua and St. Kitts alone would more than cover the expense of the Department. Much light has been thrown on the food requirements of the cane by carefully controlled experiment. As might be expected, potash is found to be favourable, but phosphatic manures to have involved monetary loss. Dr Watts, who has been the pioneer in the promotion of central factories, has obtained an increased production of 40 per cent. more than the 'Muscovado system'. Nor is this all. The pests and diseases by which the sugar-cane, like all other cultivated plants, is attacked had to be combated. The Cambridge School was drawn upon for mycologists and entomologists. Mr. Maxwell-Lefroy achieved a notable success in discovering the means of controlling the destructive moth borer.

The upshot is that a moribund industry has been given a new lease of life by bringing scientific method to bear upon it. *Laissez faire* would say that the planters might have done it for themselves. But they did not, and, in fact, could not; a scientific campaign can no more be conducted by amateurs than a military one; the planters would not have known what positions to attack, nor could they have found the necessary men to do it nor directed them if they had.

Other industries had to be revived or created. Perhaps the most important of these was the production of Sea Island cotton with the generous help of the United States.

Lastly, but by no means least, an efficient system of rural education has been organized for the negro peasantry. I have no hesitation in saying that it is far in advance of anything which exists in the county where I am writing.

And thus Sir Charles Lucas, speaking from the perspective of the Colonial Office, is able to say that 'while the eighteenth century saw the greatness of the West Indies, the nineteenth their distress, the twentieth century, he hoped, would witness their regeneration.'

But this is not the end of the story. What has been accomplished in the West Indies has not been without its effect as an object-lesson elsewhere. It is to the credit of the Government of India that it has been, as already remarked, in advance of its time in pioneering work. It deprived China of the monopoly of tea, and, with the help of Kew, it has created the rubber industry of the East. But except as regards forestry it has effected little in intensive cultivation.

Canning claimed that he brought the New World to redress the balance of the Old. The Department of Agriculture for the West Indies has stimulated a new activity in the East, where some of its trained officers have found a larger scope for work. The recently published 'Report of the Board of Scientific Advice for India' shows an awakeness and initiative which would have been looked for in vain a dozen years ago.

CHIEF MATTERS CONCERNING DEPARTMENTAL ADMINISTRATION.

On the establishment of the Imperial Department of Agriculture in October 1898, the first care of the Commissioner was to foster those agencies already in existence which made for agricultural progress In most or all of the colonies, there existed something in the nature of Agricultural Departments, Botanic and Experiment Stations and similar agencies, and steps were at once taken to place these on a satisfactory footing. At the same time, care was exercised in securing the continuity of the work already accomplished in each colony; therefore every use was made of the organizations that were already available, and the old activities were carried on under the new administration, as far as possible, with only those modifications that were directly suggested for the obtaining of increased efficiency.

There were in the larger colonies, in most cases, organizations that merely required consolidation and official sympathy and encouragement to enable them to discharge usefully and effectively their work of investigation and direction of agricultural effort.

The similar organizations in the smaller communities were in most cases in a depressed condition, and those responsible for their maintenance were faced with great difficulties, which were particularly connected with their financial support. Active measures were at once taken to place them on a sound footing: financial aid was given, the various staffs were strengthened, and vigorous lines of agricultural work and investigation were rapidly developed. It is impossible to set out at length the work that was accomplished, but the results are to be seen in the progress of the colonies, and are so interwoven with the general story of development that it is difficult, or may be invidious, to deal separately with matters concerning the growth in individual colonies. A fair idea of the extent of this progress is obtained by reference to the agricultural and economic reports of the different colonies.

In connexion with the larger colonies, the work of the Imperial Department of Agriculture consisted principally in consulting with the Governments in relation to matters of general agricultural policy in the endeavour to promote the welfare of the colonies along common lines, and to secure such a degree of uniformity of thought and action as would tend to combine the interests of the different parts of the West Indies in a greater degree than that which had hitherto obtained. In effecting this, the various Agricultural Conferences, referred to in another place, had a very marked influence, and secured a community of thought and action hitherto unknown in West Indian affairs. It is difficult to measure the precise effect and value of these; they may, however, be regarded as having been extremely important, and deserving of abundant support to ensure continuance.

There was, in addition to this, a measure of direct financial assistance, which is referred to later. It may, perhaps, be stated that the existence of the financial help might have tended to obscure the value of some of the other efforts, in bringing it about that almost the whole of the assistance was likely to be regarded as being of the nature of monetary grants to enable work to be done. This is not an accurate view of the conditions, for the assistance given by the Department, in aiding the co-ordination of effort, has continued to possess its value, after the matter of financial aid has ceased to exist.

The labours in the smaller colonies have been of a more extended and intimate character than in the case of the larger ones. Here, in addition to the functions performed by him in the case of the larger colonies, the Commissioner of Agriculture has exercised an advisory control in technical matters and, in addition to maintaining correspondence with the respective Governments on matters of general agricultural policy, he has kept in communication with the officers of the local departments of agriculture, and has advised with regard to the detailed work carried on in each colony, including the work of the Botanic and Experiment Stations and agricultural education.

To all the colonies in this class there has been granted a very large measure of financial assistance; indeed, in the early stages the cost of the maintenance of local departments of agriculture, together with much that was concerned with agricultural education and many lines of work relating to agricultural progress and development, was borne by the Imperial Grant-in-aid.

The work has been of so complex a character that it is extremely difficult to present a story which shall do justice to all its phases, or to put forward an account in which every part stands in correct proportion. It becomes necessary, therefore, to deal with various features of the work in separate sections.

The notes in the following section are intended mainly to show the financial aspect of the case, and to indicate in general terms the principal directions in which expenditure has been incurred; no attempt is made to describe in detail the results obtained, this view of the work being dealt with subsequently.

In connexion with the financial aid that was given, it is well to point out that all appropriations were placed on the Colonial Estimates, and administered under the advice of the Commissioner of Agriculture. It should be observed here, that in most cases where the Imperial Grant-in-aid shows a falling off in amount, or even ceases, the work formerly carried on with the aid of the grants has been maintained by appropriations from colonial funds. At this stage, it is convenient to give attention to the details in connexion with the different colonies.

JAMAICA.

The amounts appropriated to this colony from the Imperial Agricultural Grant have been as follows :—

	£	s.	d.
1899-1900	88	10	6
1900-1	489	19	0
1901-2	450	0	0
1902-3	450	0	0
1903-4	312	0	0
1904-5	224	11	6
1905-6	250	0	0
Total	£2,265	1	0

This colony, being distantly separated from the other West Indian Islands and having considerable financial resources, required less help than most of the others. The Commissioner of Agriculture was consulted with regard to the general agricultural policy, and paid five visits to the colony—in 1899, 1901, 1903, 1905 and 1907.

As an outcome of the general tendency throughout the West Indies, there has been, during the period under review, considerable re-arrangement in connexion with local agricultural administration, and various departments have been grouped together into a Department of Agriculture for the Colony.

The financial help rendered through the Imperial Department of Agriculture was devoted to providing the services of a Lecturer in Agriculture.

BRITISH GUIANA.

The appropriations from the Imperial Agricultural Grant have been :—

	£	s.	d.
1899-1900	348	18	7
1900-1	755	8	5
1901-2	550	0	0
1902-3	550	0	0
1903-4	550	0	0
1904-5	548	7	0
1905-6	550	0	0
Total	£3,852	14	0

In the Report of the Royal Commission of 1897, par. 34, p. 85, reference is made to the investigations that were in progress in this Colony in connexion with experiments with sugar-canes, and it was considered desirable that some assistance should be furnished through the Imperial Department of Agriculture to aid a line of work most usefully begun. The above-mentioned appropriations were therefore devoted to this object, and were applied partly in the payment of salaries of assistants engaged in the work at the Experiment Station and partly in meeting expenses incidental to the field work. No further appropriations have been made since 1906.

In this Colony, a considerable amount of re-organization has taken place in relation to the departments connected more directly with agricultural work, and there now exists under statutory authority a well-equipped Department of Science and Agriculture.

TRINIDAD AND TOBAGO.

The following appropriations have been made to this Colony from the Imperial Agricultural Grant:—

	£	s.	d
1898-9	137	2	9
1899-1900	490	11	8
1900-1	635	14	11
1901-2	500	0	0
1902-3	500	0	0
1903-4	500	0	0
1904-5	400	0	0
1905-6	400	0	0
Total	£3,563	9	4

The foregoing sums were allocated towards the upkeep of the Botanic Station in Tobago, which was largely maintained from this grant during the period under consideration. No appropriation has been made from these funds since 1906, and the Botanic Station is now maintained entirely from local funds.

The circumstances of Trinidad were not such as to require financial assistance from the Imperial Agricultural Grant.

Very considerable activity has been manifested in recent years in providing for the official expression of agricultural assistance. Various departments have been linked together into a Department of Agriculture for the Colony of Trinidad and Tobago, and an extensive Board of Agriculture has also been created.

BARBADOS.

The appropriations from the Imperial Agricultural Grant to the Colony of Barbados have been as follows:—

	£	s.	d.
1898-9	625	0	0
1899-1900	1,826	4	0
1900-1	2,056	5	0
1901-2	1,900	0	0
1902-3	1,905	0	0
1903-4	1,925	0	0
1904-5	1,995	0	0
1905-6	1,895	0	0
1906-7	1,794	0	0
1907-8	1,336	0	0
1908-9	979	0	0
1909-10	979	0	0
1910-11	829	0	0
Total	£20,044	9	0

These appropriations, in the earlier years, were devoted largely to the maintenance of the experiments with sugar-canes, which had been instituted prior to the establishment of the Imperial Department of Agriculture. The substantial appropriation permitted of re-arrangement and extension of the work, and enabled the Government to second Mr. J. R. Bovell from his post as Superintendent of the Reformatory, in order to take charge of the agricultural side of these experiments. At the outset, attention was concentrated on sugar-cane experiments, and indeed the reference in the Colonial Estimates in this connexion for certain years is to sugar-cane experiments only. Later, other subjects of enquiry came under consideration, notably cotton, which has occupied much attention.

It may be well to mention that, of the foregoing appropriation of £20,044, some £5.000 has been devoted to the chemical side of the work, and some £11,300 to the agricultural.

The foregoing figures include the following matters. From the year 1899 to 1908-9 an appropriation of £350 a year was made to provide the services for Barbados of a Lecturer in Agriculture. From 1900 to 1906-7, an appropriation of £90 a year was devoted to agricultural scholarships, which were tenable at Harrison College. In the year 1907-8 this appropriation was reduced to £50, and then ceased.

It is desirable to point out that, although the Head Office of the Imperial Department of Agriculture is located in Barbados, this has not made any essential difference in the relationship between the Imperial Department and the local department as compared with the relationship to the local departments of agriculture in other colonies. The actual fact is that the local department of agriculture in Barbados arose slowly as the outcome of the financial and general assistance given by the Imperial Department of Agriculture; this is in contrast to the manner of origin of the local depart-ments in the larger colonies. The relationship was of the same character as that maintained with the similar departments in the Windward and Leeward Islands. There is no doubt, however, that Barbados derived much benefit from the closer association with the various officers of the Imperial Department that was rendered possible by the presence of the head-quarters in the colony.

These matters are of importance in presenting details of the actual dependence of the local Department of Agriculture of Barbados on the Imperial Department of Agriculture for its origin and growth. The assistance afforded, both advisory and financial, has been large, and a proper comprehension of the state of the relationships that have existed between the two Departments should make it unnecessary to point out that no monetary contribution has ever been made by the Colony of Barbados to the Imperial Department of Agriculture.

GRENADA.

The appropriations to this Colony have been :—

	£	s.	d.
1898-9	360	4	11
1899-1900	734	9	2
1900-1	811	5	10
1901-2	755	0	0
1902-3	730	0	0
1903-4	553	0	0
1904-5	410	0	0
1905-6	430	0	0
1906-7	575	0	0
1907-8	501	0	0
1908-9	250	0	0
1909-10	250	0	0
Total	£6,359	19	11

The appropriations were devoted to the maintenance of the Botanic Station, which had been established in 1887 with the object of providing a collection of economic plants, and to afford a medium for the exchange of information and the study of problems connected with the staple industries of the colony. Experiment and demonstration plots were established, in addition, in various parts of the country. Other work included the provision of lectures to teachers in Elementary Schools and assistance in affording instruction in agricultural practice to a limited number of pupils. Arrangements were also made for supplying the services of an Agricultural Instructor, whose duty it was to travel through the country, affording instruction to peasant cultivators in the management of their crops, superintending the work connected with the experiment and demonstration plots, and serving as a connecting link between the Botanic Station and agriculturists generally. During the time, a small expenditure of £150 was made on account of an agricultural scholarship, tenable at Harrison College, Barbados.

In 1905, an effort was made to increase the scope of the work by placing the station in charge of an officer who had received a general training in science. A wider range of subjects, embracing problems connected with agricultural chemistry and the pests and diseases of crops, was thus brought within the compass of the work of the Station.

With the diminishing Imperial Grant, the charge of maintenance was borne in increasing amount by local funds, the final contribution from Imperial funds being made in 1909-10. In this year, complete re-organization took place : a local Department of Agriculture was created under Ordinance No. 8 of 1909, the general control being vested in a Board of Agriculture, while the detailed work is carried out by a Superintendent of Agriculture, and the necessary staff. Definite provision is made for performing the work in consultation with the Imperial Commissioner of Agriculture, and the local department is closely linked with the Imperial Department of Agriculture in an efficient manner. With the re-organization, the scope of the work has been extended ;

a chemical laboratory has been added, and the hope is that, with this laboratory, with the Botanic Station and various experiment stations throughout the country, and with officers travelling from place to place, there is now created a local Department of Agriculture which will be able to carry on work advancing knowledge, and will form a bureau of agricultural intelligence capable of assisting materially the agricultural efforts in the Colony.

It is important to realize that, by the affiliation referred to above, the services of the scientific officers of the Imperial Department of Agriculture are available, without cost, to supplement the efforts of the local officers—an arrangement affording the Colony the benefit of the services of a wide range of scientific help and guidance.

As has been indicated already, the whole cost of the rearranged Department of Agriculture for Grenada is borne by local funds.

ST. VINCENT.

The appropriations from the Imperial Agricultural Grant have been as follows :—

	£	s.	d.
1898-9	271	1	6
1899-1900	1,082	14	8
1900-1	2,778	7	7
1901-2	1,623	12	11
1902-3	1,425	0	0
1903-4	1,400	0	0
1904-5	1,318	0	0
1905-6	1,222	0	0
1906-7	1,299	0	0
1907-8	913	0	0
1908-9	585	0	0
1909-10	585	0	0
1910-11	585	0	0
Total	£15,087	16	8

The first care of the Imperial Department of Agriculture was to make provision for the adequate maintenance of the Botanic Station, which occupies a portion of the site of the Botanic Garden established in 1765; this garden is believed to be the first institution of its kind in the West Indies, and possibly in the New World. By making this Station the centre of agricultural effort, it was hoped that benefits might accrue to the Colony from the improvement of agricultural methods and the direction of energies into new channels—a hope that has been abundantly justified.

This assistance was rendered imperative on account of the disastrous hurricane of September 1898, and in connexion with the various plans that were devised for ameliorating the conditions that existed subsequently. In connexion with these plans, at about the same time that aid was first rendered to the Colony through the Imperial Department of Agriculture, there was established a Land Settlement Scheme, having for its object the provision of land for cultivation by the peasantry. The need for such land was increased by the effects of the hurricane mentioned. Much work connected with this scheme has been performed by the local Department of Agriculture; the allottees are carefully supervised in the working of their holdings by an Agricultural Instructor, who carries out his duties under the direction of the Agricultural Superintendent. The services of this officer have not been a charge upon the foregoing appropriations.

The large appropriation for the year 1900-1 is accounted for by the establishment in that year of an Agricultural School. In this school, from about fifteen to twenty boys are maintained and trained in agriculture. The work of the establishment is conducted as part of the Agricultural Department, and is under the charge of a Resident Master who reports to the Agricultural Superintendent. The school possesses good buildings, and stands in grounds cultivated by the pupils as part of their training. The cost of the maintenance of the Agricultural School has been entirely met from the Imperial Agricultural Grant.

A Government Veterinary Department, the work of which is carried out under the Agricultural Department, was established in 1907. The cost of this is borne by local funds.

In 1903, the cultivation of cotton was started experimentally by the Imperial Department of Agriculture; from that time onwards very substantial progress has been made, until now cotton-growing constitutes the most important industry of the Colony. A very considerable part of the financial appropriation of the earlier years of the period under review must be regarded as applied to the establishment of the cotton industry.

Small appropriations were made for lectures to teachers in elementary schools in 1904-5 and 1905-6.

With the diminishing Imperial Grant, the charge of maintaining the local Department of Agriculture has been met from local funds.

The disastrous eruption of the Soufrière in 1902 exercised the energies of the officers of the local Department of Agriculture who assisted in reporting on the devastated districts and on the steps to be taken to provide for those driven from these lands, as well as in devising measures for reclaiming the affected areas when the volcanic activity ceased. An account of the nature of the work that was done, particularly in relation to the Land Settlement Scheme, is given in the *West Indian Bulletin*, Vol. XI, p. 194.

ST. LUCIA.

The appropriations from the Imperial Agricultural Grant allotted to this Colony have been :—

	£	s.	d.
1898-9	341	15	10
1899-1900	1,058	10	2
1900-1	1,130	13	7
1901-2	1,500	0	0
1902-3	1,347	0	0
1903-4	1,347	0	0
1904-5	1,196	10	0
1905-6	1,227	8	1
1906-7	918	0	0
1907-8	715	0	0
1908-9	500	0	0
1909-10	500	0	0
1910-11	500	0	0
Total	£12,281	17	8

The appropriations were principally expended upon the maintenance of the Botanic and Experiment Stations and the Agricultural School. In 1899, provision was made for an Agricultural Instructor, whose duty was to travel through the country for the purpose of advising on agricultural matters; this officer also had charge of the experiment and demonstration plots situated in country districts.

For five years a scholar from St. Lucia held the Agricultural Scholarship tenable at Harrison College, Barbados, provision for which is included in the sums mentioned above.

With the reduction of the Imperial Agricultural Grant the work of the Botanic and Experiment Stations has been maintained, practically in its entirety, by appropriations from local funds.

LEEWARD ISLANDS.

The following appropriations from the Imperial Agricultural Grant have been made to the Leeward Islands Federal Government :—

	£	s.	d.
1899-1900	703	9	1
1900-1	1,106	4	4
1901-2	1,425	0	0
1902-3	1,215	0	0
1903-4	1,338	0	0
1904-5	1,472	0	0
1905-6	1,365	0	0
1906-7	1,365	0	0
1907-8	1,370	0	0
1908-9	1,040	0	0
1909-10	1,040	0	0
1910-11	760	0	0
Total	£14,199	13	5

The foregoing sums were applied to the object of maintaining a central scientific establishment having an interest in the agricultural work throughout the Leeward Islands; this establishment was provided with a fairly well equipped chemical laboratory and staff, and served as a place of reference for scientific questions for the Colony. A considerable part of the work of the experiments with sugar-cane, cotton, cacao and other crops, as well as in connexion with general agricultural matters, has been carried out from this centre, in collaboration with the officers of the various local Departments of Agriculture. For the furtherance of this work the senior officers have visited the various Presidencies, provision for their travelling being included in the appropriations.

An Agricultural Scholarship having an annual value of £75 a year, tenable at Harrison College, Barbados, is included in the foregoing for the years 1901 to 1907, inclusive.

The following are the details of expenditure and general administration in the different Presidencies of the Government of the Leeward Islands:—

ANTIGUA.

The appropriations for this Presidency have been:—

	£	s.	d.
1898-9	104	8	5
1899-1900	509	10	0
1900-1	944	3	9
1901-2	649	0	0
1902-3	630	0	0
1903-4	880	0	0
1904-5	984	2	6
1905-6	934	2	6
1906-7	934	11	11
1907-8	904	0	0
1908-9	671	0	0
1909-10	671	0	0
1910-11	671	0	9
Total	£9,486	19	1

These appropriations were devoted to the maintenance of the Botanic and Experiment Stations dealing with the general agricultural problems of the Presidency, particular attention being given to work with sugar-cane and cotton; though practical consideration has been afforded to a wide range of industries. In the re-introduction of the cotton industry, the work of establishing and running the cotton ginnery, subsequently transferred to a local company as a going concern, was entrusted to the officers of the Department of Agriculture, and successfully carried out.

The above appropriations include a sum of £265 a year, from 1903-4, for the purpose of affording instruction in science and agriculture in the secondary schools. An Agricultural and Science Master was appointed in 1902, who gave instruction at the Grammar School and other secondary schools, as well as lectures to elementary teachers. The amount mentioned in the appropriation made provision of £70 to £90 a year for agricultural scholarships tenable at the Grammar School.

ST. KITTS-NEVIS.

The following appropriations were made to this Presidency :—

	£	s.	d
1898-9	285	19	4
1899-1900	908	11	2
1900-1	1,146	17	11
1901-2	895	0	0
1902-3	910	0	0
1903-4	910	0	0
1904-5	1,130	0	0
1905-6	1,185	0	0
1906-7	1,185	0	0
1907-8	1,115	0	0
1908-9	780	0	0
1909-10	780	0	0
1910-11	580	0	0
Total	£11,811	8	5

The appropriation for this Presidency covers expenditure in the islands of St. Kitts, Nevis and Anguilla. The Botanic and Experiment Stations in St. Kitts were, in the earlier years, maintained entirely from the Imperial Agricultural Grant, and a subsidiary station in Nevis was established and maintained. Much attention was given to work connected with the sugar industry, and later on to the cotton industry also, in all these islands.

A provision ranging from £225 to £250 per annum is included in the foregoing, for the maintenance of an Agricultural Instructor and an Experiment Station in Nevis; this has been supplemented later by a grant from local funds.

It was originally proposed to constitute an Agricultural School in St. Kitts, on the lines of those established in St. Vincent, St. Lucia and Dominica; the proposals were subsequently modified, however, and instruction in science and agriculture was provided for in the St. Kitts Grammar School—a Government institution revived in 1901. For this purpose, an Agricultural and Science Master was appointed, and an annual provision of £240 made, from 1902-3, for his maintenance and the upkeep of about eight agricultural scholarships.

DOMINICA.

The appropriations to this Presidency have been as follows :—

	£	s.	d.
1898-9	700	4	3
1899-1900	1,455	14	8
1900-1	1,614	15	6
1901-2	1,445	0	0
1902-3	1,420	0	0
1903-4	1,420	0	0
1904-5	1,420	0	0
1905-6	1,335	0	0
1906-7	1 065	0	0
1907-8	890	0	0
1908-9	645	0	0
1909-10	645	0	0
1910-11	615	0	0
Total	£14,670	14	5

The maintenance of the Botanic Gardens and Experiment Stations was the first consideration, on the establishment of the Imperial Department of Agriculture, and this absorbed a considerable part of the appropriation ; in later years, as the grant diminished, the maintenance of the stations has been provided from local funds.

In 1900, an Agricultural School was established for the provision of instruction in practical agriculture ; accommodation was provided for some twenty pupils. This involved an expenditure of about £550 a year from the above-mentioned grants. It will thus be seen that in later years the appropriation has been largely applied to the maintenance of the Agricultural School.

An Agricultural Instructor was appointed in 1900, and continued to hold office until 1905. Another matter having reference to agricultural instruction is that three courses of lectures to elementary teachers were given in 1900-1 and 1901-2.

MONTSERRAT.

The appropriations have been :—

	£	s.	d.
1899-1900	239	14	7
1900-1	895	2	4
1901-2	512	0	0
1902-3	615	0	0
1903-4	500	0	0
1904-5	550	0	0
1905-6	550	0	0
1906-7	550	0	0
1907-8	600	0	0
1908-9	550	0	0
1909-10	550	0	0
1910-11	400	0	0
Total	£6,511	16	11

The appropriations have been devoted almost entirely to the maintenance of the Botanic and Experiment Stations and the affairs relating to them. In this Presidency, efforts connected with Botanic Stations such as had been maintained in most of the West Indian Islands, had been suspended, so that it was necessary to organize the work from the beginning. This necessitated a relatively large outlay in 1900-1. In 1899, Montserrat experienced a disastrous hurricane; consequently much of the early work of the agricultural officers was devoted to assisting the peasantry to restore their holdings and ameliorate their condition; while, in connexion with the same matter, a large distribution of useful planting material was made from the Botanic Station.

The introduction of cotton-growing as an industry has afforded much scope for successful work on the part of the local Department of Agriculture and the organizations with which it is connected, and this work has been of the greatest importance in relation to the largely increased prosperity of Montserrat in recent years.

A small amount of expenditure was incurred between the years 1901-2 and 1907-8, in connexion with the work of a local Agricultural Instructor.

Courses of lectures and demonstrations to elementary teachers were given in 1900, 1901, 1902 and 1906.

VIRGIN ISLANDS.

The appropriations from the Imperial Agricultural Grant have been:—

	£	s.	d.
1900-1	794	6	4
1901-2	511	0	0
1902-3	510	0	0
1903-4	547	0	0
1904-5	590	0	0
1905-6	550	0	0
1906-7	550	0	0
1907-8	550	0	0
1908-9	550	0	0
1909-10	550	0	0
1910-11	490	0	0
Total	£6,192	6	4

Prior to the efforts for which these appropriations were made, nothing had been attempted in the way of Botanic or Experiment Stations in these islands. It became necessary, therefore, to obtain land and to lay out the station required for the work, and then to determine the line along which agricultural progress should be directed. Peculiar difficulties existed, in that the land-holders are principally peasants who are more accustomed to seafaring occupations than to agriculture.

The earlier work was devoted to an attempt to develop a small land settlement scheme, under which the land-holders were to be guided and assisted by the newly formed Agricultural

Department. At the same time, provision was made for assisting these land-holders and other peasants in reaping their small crops of sugar.

The development of the cotton industry in other parts of the West Indies soon had its influence in the Virgin Islands. As there now existed a definite agricultural organization, it became possible to introduce and foster the cultivation of cotton, first in the Experiment Station and subsequently on the holdings of the peasantry. In the course of a few years, a substantial cotton industry was established, that has entirely altered the conditions of life in these islands. To accomplish this, it has been necessary for the Agricultural Department to develop not only the agricultural side of the cotton industry, but also to provide all the required machinery for ginning and baling the cotton, and in effect, to purchase and ship it; thus the whole of the work, short of the actual growing and picking of the cotton, has been undertaken by the Agricultural Department.

Some portion of the expenditure incidental to providing the cotton ginnery fell upon the appropriations above recorded; but as the industry became remunerative, the further cost was met from local funds. It should be added that the British Cotton Growing Association has afforded assistance that is much appreciated towards the acquiring of the machinery necessary for preparing the crop for export.

In making the efforts outlined in the foregoing paragraphs, the work of the Head Office and its Staff has played an important part. It has been necessary for the Commissioner to pay frequent visits to the various islands, and a very considerable amount of time has been taken up in travelling. In the early stages, the services of a travelling assistant were engaged, but as the work was gradually organized it was found that these were less essential, and the technical expert officers such as the Entomologist and the Mycologist were caused to spend more time in travelling, in order that they may attend directly to matters of more particular urgency in the different islands.

By means of frequent visits and abundant correspondence, a sound knowledge of the work in progress in each island has been acquired and recorded at the Head Office, and in return advice for the guidance of local officers has been issued. The interchange of views has been of conspicuous service, and largely instrumental in securing the successful progress that is to be reported.

Periodical reports of the work in each island have been furnished by the responsible officers. These are printed and widely circulated, thus not only bringing under the notice of the communities in which the work is done information as to what is being attempted and achieved, but also making the information available for a wider range of readers; so that matters of agricultural knowledge are exchanged between various communities, and in turn the energies of the workers are further stimulated.

It soon became evident that good results would follow if means existed for inculcating knowledge and exchanging information in a wider manner than was possible by means of visits, correspondence and reports, and to this end two journals were founded. The first of these is the *West Indian Bulletin*, which is intended to form a medium for the publication of papers relating to agricultural research and progress, and to provide a means of placing on record the weightier results obtained as work continues. The second is the *Agricultural News*, a fortnightly journal intended for the circulation of information of general agricultural interest and of a more ephemeral character.

The Annual Reports, the *West Indian Bulletin* and the *Agricultural News* have been published regularly, as far as possible at definite intervals. In addition to these, the Department issues Pamphlets and Leaflets, from time to time, the former of which constitute a definite Series containing sixty-eight numbers, so far. These pamphlets are an important part of the matter published by the Department, as they deal in an essentially practical manner with a wide range of subjects of agricultural interest, in the West Indies.

Research work in Entomology and Mycology has been carried on in the laboratories attached to the Head Office, and by this means valuable additions have been make to our knowledge of insect and fungus pests of crops, and there has been in addition the circulation of a large amount of knowledge respecting these subjects, for the information and guidance of agricultural officers and the planting communities throughout the West Indies.

Viewed broadly, the work of the Imperial Department of Agriculture may be seen to have consisted largely in strengthening, restoring and giving stability to efforts directed toward the increase of agricultural knowledge, and in widening the range of agricultural practice which existed in some form or other in various parts of the West Indies prior to its establishment. It was recognized that these efforts, properly sustained and directed, were capable of working great improvements in the condition of these colonies; it was further perceived that the want of stability and co-ordination, and the lack of assurance of continuity were robbing existing efforts of the greater part of their usefulness, and dissipating the energies of those responsible for those efforts. By furnishing, in the first instance, funds by means of which these efforts could be utilized, and then, when the means of work were provided, pressing for full activity along various lines, material progress has been made.

A result of the work that is of some importance has been the effecting of free intercourse between the agricultural officers and agricultural communities in the scattered colonies. In this way one group has learned much from another, and the tendency has consequently arisen to look at economic agricultural and commercial problems from the broader standpoint of the West Indies as a whole, rather than from the basis of considerations having a purely local value. Unfortunately for those who are concerned more directly, some reaction has set in, as so frequently happens; so that at the moment there is a tendency in some quarters to emphasize the individuality of separate colonies, and to urge for their individual, rather than their collective, consideration.

The larger colonies having agricultural organizations on a greater scale, and industries of a more extensive and stable character, manifest less clearly the results of the work of the Imperial Department of Agriculture than is the case with the smaller ones. Information to be given later will serve to show how, in the case of the latter, the possession of means for stimulating and directing agricultural effort, and for making useful agricultural investigations, has been the immediate cause of enhanced agricultural progress and increased general prosperity. It may be said here, however, that in every direction, there is evidence of greatly heightened prosperity in all the smaller islands. This is manifested in the enlarged commerce of these colonies, and in the fact that the revenues of the Government have been raised with less difficulty, and have proved adequate to the requirements of every place; so that at the moment no colony stands in need of Imperial Grants in aid of revenue. If individual instances are required, one may point to the improved conditions of such communities as those in St. Vincent, Montserrat, Anguilla and the Virgin Islands, due almost entirely to the development of the cotton industry; further, to the stimulation of the sugar industry in Antigua by the acquisition of well-equipped modern sugar factories; and to the fact that this line of progress is now being followed in the neighbouring Presidency of St. Kitts. One may also refer to the rapidly advancing prosperity of Dominica, and the steady development of the great resources of this island. Grenada, less depressed than her neighbours some ten years ago, has maintained a condition of prosperity which is due to the careful development of her agricultural resources; while St. Lucia has devoted necessary attention to the agricultural assets of an island containing possibilities that are still far from being realized.

These points refer to some of the features of progress. They indicate an amelioration of West Indian conditions that only those intimately connected with affairs in these islands can readily appreciate. It is a fact that much of this improvement has followed the abolition of the sugar bounties in Europe; it has also been claimed to be part of a general industrial awakening, and this is true. But the main point is that, concurrently with these changes and this industrial awakening, there existed the fostering agencies involved in all that is implied in the term Department of Agriculture, and that thereby the efforts manifested in the industrial awakening, were in some cases stimulated into activity, and in most cases directed into useful channels, as matters of departmental organization to which this article has reference.

The story would not be complete without mention of the progress made in the larger colonies. Jamaica has effected rapid development in connexion with the banana and fruit industries, and has also made much progress in the introduction of improved sugar machinery. Trinidad, while maintaining its sugar industry, has extended the cultivation of cacao and fruits. With its considerable natural resources, agricultural and mineral, this Colony bids fair to develop with marked rapidity in the near future. British Guiana, like Trinidad, has continued its sugar industry on sound lines, and is in possession of well-equipped modern factories. In the way of striking development in this Colony, reference must be made to the creation and satisfactory establishment of an important rice industry, within the past few years; so that it is now in a position not only to supply its own needs in this commodity but also to export largely to the West Indian Islands.

What has been said will suffice to give a broad view of the chief matters of administration that have obtained during the first twelve years of the existence of the Imperial Department of Agriculture for the West Indies. In order to make this view as comprehensive as possible, subjects of detail have been purposely omitted, and it is left to the articles that follow to present information as to the ways in which this administration was directed and made effective.

MATTERS OF INDIRECT INTEREST.

WEST INDIAN AGRICULTURAL CONFERENCES.

Seven Agricultural Conferences have been organized and brought to a successful issue by the Imperial Department of Agriculture. Of these, five were held in Barbados, one in Trinidad, and one in Jamaica.

The first four conferences, which were all held in Barbados, owing to that island being the headquarters of the Royal Mail Steam Packet Company, only occupied two working days each, Sunday intervening In 1905, however, a conference was held in Trinidad, and on that occasion the period was extended to ten working days, when, in addition to the ordinary business of reading and discussing papers, excursions into the country were organized, to enable the representatives to visit places where experiments were being conducted, and to form some idea of the conditions under which the various crops were cultivated in the island. These excursions have since come to be regarded as forming a recognized part of the programme of Agricultural Conferences.

The full proceedings and papers read at these conferences have been published in the *West Indian Bulletin*. The following short notes will, however, furnish the principal details in connexion with each conference.

The first conference was held in Barbados in January 1899. There were representatives comprising the principal Botanical, Chemical and Educational officers from the several islands: three of these were from Jamaica, four from British Guiana, five from Trinidad, three from the Windward Islands, three from the Leeward Islands and six from Barbados.

The proceedings were opened by the Governor of Barbados, in a short speech extending a welcome to the visitors, after which the Imperial Commissioner of Agriculture, Sir Daniel Morris, K.C.M.G., who on each occasion was President of the Conference, delivered an address, in which he briefly outlined the work of the Imperial Department of Agriculture and the general conditions in the different colonies.

On the conclusion of the President's address, papers were read by the delegates. Among some of the most important were :—

Sugar-cane Manurial Experiments (*West Indian Bulletin*, Vol. I, p. 26) ;

Field Treatment of the Diseases of the Sugar-cane in the West Indies (*West Indian Bulletin*, Vol. I, p. 33) ;

Central Factories (*West Indian Bulletin*, Vol. I, pp. 43, 52) ;

Agricultural Education, The Teaching of Agricultural Science in Colleges, Agricultural Instruction in Agricultural Schools in Jamaica (*West Indian Bulletin*, Vol I, pp. 77, 94, 103) ;

The Prevention of the Introduction and Spread of Fungoid and Insect Pests in the West Indies (*West Indian Bulletin*, Vol. I, p. 133).

The second Agricultural Conference was held in Barbados in January 1900. Forty delegates from the several islands attended this conference. On this occasion, in addition to the principal Botanical, Chemical and Educational officers, there were present representatives of the Agricultural Societies of British Guiana, Trinidad, Antigua and Barbados. The officers of the Head Office Staff were also present at this and subsequent conferences.

The conference was opened by the Governor of the Colony, and the President delivered an address briefly reviewing the work of the previous year.

The following are some of the principal papers read at this conference :—

Notes on Sugar cane Experiments in British Guiana (*West Indian Bulletin*, Vol. I, p. 159) ;

The Lines of Future Work in Sugar-cane Manurial Experiments in Barbados (*West Indian Bulletin*, Vol. I, p. 172) ;

Possibility of Improving the Sugar-cane, (a) by artificial cross-fertilization, (b) by chemical selection of 'seed cane' (*West Indian Bulletin*, Vol. I, p. 182 and 185) ;

Rotation and Catch Crops on Sugar Estates (*West Indian Bulletin*, Vol. I, p. 204) ;

Green Manuring as a Means of Fertilizing Cane Lands in the West Indies (*West Indian Bulletin*, Vol. I, p. 212) ;

Central Factories in Barbados (*West Indian Bulletin*, Vol. I, p. 195) ;

Central Factories in Antigua (*West Indian Bulletin*, Vol. I, p. 200) ;

Teaching Agriculture in High Schools and Colleges (*West Indian Bulletin*, Vol. I, p. 229) ;

Teaching Agriculture in Elementary Schools) *West Indian Bulletin*, Vol. I, p. 234) ;

School Plots as Aids in Teaching Agriculture in Elementary Schools (*West Indian Bulletin*, Vol. I, p. 249);

Food Supplies of the Leeward Islands (*West Indian Bulletin*, Vol. I, p. 270);

Distribution of Economic Plants in Relation to Agricultural Development (*West Indian Bulletin*, Vol. I, p. 281);

Packing Seeds and Plants (*West Indian Bulletin*, Vol. I, p. 296);

Bee-keeping in Jamaica (*West Indian Bulletin*, Vol. I, p. 305);

Suggestions for Increasing the Usefulness of the Botanic Stations (*West Indian Bulletin*, Vol. I, p. 289).

The third Agricultural Conference was held in Barbados in January 1901, when forty-three representatives were present. The conference was opened by the Acting Governor, and the President's address read. Papers were then given on :—

Recent Experiments with Seedling and Other Canes, with Special Reference to Barbados (*West Indian Bulletin*, Vol. II, p. 23);

Cane Farming in Trinidad (*West Indian Bulletin*, Vol. II, p. 33);

Insect Pests of the Sugar-cane (*West Indian Bulletin*, Vol. II, p. 41);

Fungoid Diseases of the Sugar-cane (*West Indian Bulletin* Vol. II, p. 46);

Agricultural Education and its Place in General Education (*West Indian Bulletin*, Vol. II, p. 56):

Teaching the Principles of Agriculture in Elementary Schools (*West Indian Bulletin*, Vol. II, p. 61).

In addition to the above, several papers of a general nature were read. Among these may be mentioned :

Orchard Cultivation in the Tropics (*West Indian Bulletin* Vol. II, p, 96);

Rubber Planting in the West Indies (*West Indian Bulletin*, Vol. II, p. 100);

Marine Resources of the West Indies (*West Indian Bulletin*, Vol. II, p. 121).

The fourth Agricultural Conference was held in Barbados in January 1902. Thirty-nine representatives attended, to whom the Governor in opening the Conference extended a hearty welcome. The President delivered an address, as usual. Some of the principal papers read were : -

The Sugar Industry of Jamaica (*West Indian Bulletin* Vol. III, p. 46);

Ratooning Estates and Central Factories in Jamaica (*West Indian Bulletin*, Vol. III. p. 66);

The Field Treatment of Cane Cuttings in reference to Fungoid Diseases (*West Indian Bulletin*, Vol. III, p. 73);

The Lady-Bird or Weevil Borer of Sugar-cane (*West Indian Bulletin*, Vol. III, p. 88);

The Organization and Functions of Boards of Agriculture (*West Indian Bulletin*, Vol. III, p. 93).

A Chemical Section, which had been formed at the conference held in the previous year, met and dealt with questions that could not be profitably discussed in open conference, and submitted a report.

An Educational Section was appointed to discuss educatio na matters, and a report was submitted.

Among the general subjects dealt with may be mentioned :—

The Regulation of the Quality of Exported Fruit (*West Indian Bulletin*, Vol. III, p. 131);

Suggestions for Controlling the Importation of Insect Pests (*West Indian Bulletin*, Vol. III, p. 140);

Banana Industry of Jamaica (*West Indian Bulletin*, Vol. III, p. 153).

No conferences were held in 1903 and 1904, owing to quarantine restrictions.

The fifth Agricultural Conference was held in Trinidad, in January 1905, and occupied ten days. Thirty-two representatives were present, and after the usual preliminaries, papers were read on the following subjects, among others :—

Seedling Canes and Manurial Experiments in the West Indies (*West Indian Bulletin*, Vol. V, pp. 335-88);

Cane Farming in British Guiana and Trinidad (*West Indian Bulletin*, Vol. V, p. 1);

The Central Sugar Factory in Antigua (*West Indian Bulletin*, Vol. V, p. 60);

Fungoid Diseases of, and Insect Pests attacking, Cacao (*West Indian Bulletin*, Vol. V, pp. 85 and 94);

Experiments in Cultivation of Cotton in the West Indies (*West Indian Bulletin*, Vol. V, p. 109);

Fungoid Diseases and Insect Pests of Cotton (*West Indian Bulletin*, Vol. V, pp. 117 and 123);

Raiffeisen Agricultural Banks (*West Indian Bulletin*, Vol. V, p. 129);

Anthrax (*West Indian Bulletin*, Vol. V, p. 156);

Rice Cultivation in British Guiana and Trinidad (*West Indian Bulletin*, Vol. V, p. 170).

On this occasion, as there was more time at the disposal of the delegates, excursions were organized for their benefit, by the Trinidad Agricultural Society, to various places of interest in the Island. These excursions were the means of enabling the representatives to obtain a good idea of methods of cultivation adopted by Trinidad planters.

No conference was held in 1906.

The sixth Agricultural Conference, which promised to be of particular interest in view of the presence of a large and distinguished party brought out by Sir Alfred Jones, K.C.M.G., was intended to be held in Kingston, Jamaica, in January 1907.

There were thirty-five delegates present, and Sir Alfred Jones and many of his party were made honorary members.

Extensive arrangements had been made for the entertainment of the delegates during their stay in the Colony, and excursions to several parts of the island had been arranged. Unfortunately, however, although some of these plans were carried out, in the afternoon of the first sitting of the conference, the disastrous earthquake that practically destroyed Kingston and its environs took place, and the conference had to be adjourned.

The conference was resumed on board the S.S. 'Port Kingston' during the return journey to Barbados, and particulars of the cotton industry in the West Indies were given by some of the members.

Some of the papers which were to have been read at the conference were subsequently printed in the *West Indian Bulletin*, Vol. VIII, pp. 26-310.

The seventh Agricultural Conference was held in Barbados in January 1908. At this conference there were forty-two delegates. The proceedings, including excursions into the country, occupied seven days.

On the conclusion of the Governor's opening speech and the President's address, several interesting papers were read and discussed. Among the more important of these dealt with :—

Varieties of Sugar-cane and Manurial Experiments in British Guiana (*West Indian Bulletin*, Vol. IX, p. 1);

Sugar-cane Experiments at Barbados (*West Indian Bulletin*, Vol. IX, p. 39);

Sugar-cane Experiments in the Leeward Islands (*West Indian Bulletin*, Vol. IX, p. 63);

The Central Sugar Factory at Antigua (*West Indian Bulletin*, Vol, IX, p. 79);

Observations on the Work of Sugar-cane Mills (*West Indian Bulletin*, Vol. IX, p. 85);

Root Diseases of Sugar-cane (*West Indian Bulletin*, Vol. IX, p. 103);

Establishment and Working of the Sugar Industry Agricultural Bank at Barbados (*West Indian Bulletin*, Vol. IX, p. 133);

Results of the Recent Experiments with Cacao in the West Indies (*West Indian Bulletin*, Vol. IX, pp. 138-56);

The Improvement of Cacao in the West Indies (*West Indian Bulletin*, Vol. IX, p. 162);

The Fungus Diseases of Cacao and Sanitation of Cacao Orchards (*West Indian Bulletin*, Vol. IX, p. 166);

Thrips on Cacao (*West Indian Bulletin*, Vol. IX, p. 190);

Experiments with Citrate of Lime and Concentrated Lime Juice (*West Indian Bulletin*, Vol. IX, p. 193);

The Cotton Industry of the West Indies (*West Indian Bulletin*, Vol. IX, pp. 195-243);

Rice Industry of British Guiana (*West Indian Bulletin*, Vol. IX, p. 246);

Rubber Industry (*West Indian Bulletin*, Vol. IX, p. 252);

Central Experiment Stations (discussion), (*West Indian Bulletin*, Vol. IX, p. 258);

Notes on the Value of Introduced Parasites or Beneficial Insects (*West Indian Bulletin*, Vol. IX, p. 262).

No conferences were held in 1909 and 1910, experience having suggested that it would be more useful to hold a conference every third year instead of annually.

On the invitation of the Government of British Guiana that the next conference should be held in that Colony, the Imperial Commissioner of Agriculture visited the Colony and, in consultation with His Excellency the Governor and Professor Harrison, C.M.G., Director of Science and Agriculture, together with a committee appointed in connexion with the matter, made the preliminary arrangements for holding a conference there in January 1911. Owing, however, to the unsettled state of affairs in regard to the movements of the steamers of the Royal Mail Steam Packet Company at this period, it was found to be impossible to arrange for the representatives from all the islands to meet in Georgetown, and the conference was reluctantly postponed.

AGRICULTURAL SHOWS.

The first Agricultural Show under the auspices of the Imperial Department of Agriculture was held in Dominica on February 16, 1899, when a Grant-in-aid of £15 was made to provide prizes. After this, Agricultural Shows were held periodically in all the smaller islands, and grants of money made by the Department in aid of the prize fund. In addition to the money prizes, Diplomas of Merit, specially designed for the use of the Department, were awarded for exhibits of an exceptionally valuable character.

These shows were organized mainly in the interest of the peasants and small holders, and were intended to encourage them especially to cultivate provision crops and fruit, and to raise stock, of a good quality, as well as to prepare the former properly for market, and to employ the best methods for making preserves, starches, etc.

Although they were at first inclined to look upon them with doubt and suspicion, the peasants have subsequently learned that they can derive a considerable amount of benefit from the shows, not only by winning money prizes, but also by adopting the advice which they receive from the officers of the Department, as to how they should cultivate and prepare their produce for market so as to fetch better prices. Their confidence having been gained, they usually now look forward eagerly to the date of the show; and the competition in the different classes of exhibits, which are varied and numerous, is at present well sustained.

With a view to encouraging the pupils of elementary schools, with special reference to the work in school gardens, prizes are offered, in some islands, for the best exhibits of plants and vegetables grown by children in these gardens, and the competition in these classes is also very keen.

The holding of an agricultural show is often made an occasion for a holiday, and large numbers of persons attend the show, when an enjoyable and instructive time is generally spent.

A schedule is appended, giving details of the dates on which agricultural shows have been held under the auspices of the Imperial Department of Agriculture in the several Colonies, and of the amounts in each case of the grant from Imperial funds.

The total sum expended on these shows, to March 31, 1911, is in round numbers £1,200.

There can be no doubt that a considerable amount of good has already been accomplished, through the holding of Agricultural shows, as is demonstrated by the improvement in the exhibits offered for competition. Much more, however, still remains to be done, which can only be achieved in time, and by continued efforts to maintain the interest that has been aroused.

DETAILS CONCERNING AGRICULTURAL SHOWS HELD UNDER THE AUSPICES OF THE DEPARTMENT.

Colony.	Date of Show.	Amount of Grant.			No of Diplomas of Merit awarded.
		£	s.	d.	
ST. VINCENT.	March 10, 1904	20	0	0	30
	March 9, 1905	25	0	0	12
	March 7, 1906	25	0	0	12
		70	0	0	54
ST. LUCIA.	March 25, 1899	30	0	0	...
	June 30, 1899	30	0	0	...
	March 24, 1900	15	0	0	...
	Dec. 14, 15, 1900	35	0	0	15
	May 2, 1901	15	0	0	...
	March 27, 1903	20	0	0	...
		145	0	0	15
BARBADOS.	Jan. 15, 1901	40	0	0	2
	1902	25	0	0	6
	Jan. 13. 1903	25	0	0	5
	Jan. 12, 1904	15	0	0	7
	Jan. 24, 1905	20	0	0	6
	Dec. 5, 1905	20	0	0	9 (offered)
	Dec. 4, 1906	30	0	0	11
	Dec. 1907	10	18	2	16
	Dec. 9, 1908	30	0	0	10 (offered)
	Dec. 1909	...			10 (offered)
	Dec. 1910	...			...
		215	18	2	82
DOMINICA.	Feb. 16, 1899	15	0	0	...
	Feb. 16, 1900	25	0	0	...
	Feb. 14, 1901	25	0	0	25
	Feb. 13, 1902	25	0	0	7
	Feb. 11, 12, 1903	25	0	0	7
	Feb. 23, 1904	25	0	0	10
	Feb. 23, 1905	25	0	0	9
	Feb. 23, 24, 1906	25	0	0	10
		190	0	0	68
MONTSERRAT.	March 28, 1899	30	0	0	...
	Feb. 26, 1901	25	0	0	15
	Feb. 27, 1903	10	0	0	6
	Feb. 25, 1904	15	0	0	10
	Feb. 24, 1905	15	0	0	6
	Nov. 9, 1906	6	0	0	5
	Feb. 15, 1911	15	0	0	6
		116	0	0	48

DETAILS CONCERNING AGRICULTURAL SHOWS HELD UNDER THE AUSPICES OF THE DEPARTMENT. (*Continued.*)

Colony.	Date of Show.	Amount of Grant.	No of Diplomas of Merit awarded.
ANTIGUA.	Dec. 21, 1900	25 0 0	25
	April 1901	(*Cane Show*)	...
	Feb. 14, 1902	25 0 0	20
	Feb. 19, 1903	25 0 0	20
	Feb. 25, 1904	25 0 0	20
	Feb. 23, 1905	25 0 0	20
	Feb. 22, 1906	25 0 0	20
	Feb. 28, 1907	25 0 0	12
	Nov. 25, 1909	25 0 0	20
	Feb. 23, 1911	25 0 0	12
		225 0 0	169
ST. KITTS.	March 5, 1907	15 0 0	8
	Feb. 13, 1908	30 0 0	8
	Feb. 13, 1909	...	8
	Feb. 17, 1910	25 0 0	10
	Feb. 24, 1911	25 0 0	12
		95 0 0	46
VIRGIN ISLANDS.	Sept. 23, 1899	15 0 0	24*
	July 28, 1900	20 0 0	10
	Sept. 28, 1901	25 0 0	10
	Oct. 29, 1902	20 0 0	10
	Oct. 7, 1903	20 0 0	12 (offered)
	Sept. 13. 1905	20 0 0	...†
	Oct. 24, 1906	20 0 0	...†
	Dec. 14, 1910	20 0 0	6
		160 0 0	72

* Special diplomas.
† No record.

[It should be recorded that the above figures do not include diplomas that have been granted by the Imperial Department of Agriculture in the case of the Industrial Exhibitions held annually by the Barbados Agricultural Society.]

VISITS OF THE COMMISSIONER OF AGRICULTURE TO THE UNITED STATES OF AMERICA AND CANADA.

The Commissioner of Agriculture paid visits to the United States of America and Canada in September 1902, September 1903 and August 1906 and 1907.

The primary object of the visit in 1902 was to attend an International Plant-breeding and Hybridization Conference in New York. A paper by L. Lewton-Brain on Hybridization of the Sugar-cane (*West Indian Bulletin*, Vol. IV, p. 63) was read by the Commissioner of Agriculture (Sir Daniel Morris, K.C.M.G.) In addition to attending the Conference, the Commissioner made arrangements in connexion with several matters having relation to the general work of the Imperial Department of Agriculture. The most important of these was the securing of reliable agents to sell and ship pedigree animals from the United States and Canada to improve local breeds in the West Indies, as the freight on animals from the United Kingdom rendered their importation from that source prohibitive.

In September of the following year, the Commissioner of Agriculture again visited the United States of America. On this occasion he was accompanied by Mr. J. R. Bovell, Superintendent of Agriculture for Barbados.

It was at this time that active steps began to be taken to revive the cultivation of Sea Island cotton in the West Indies, and the Commissioner and Mr. Bovell obtained the sanction of the Secretary of State for the Colonies to their visiting South Carolina and Georgia, with a view to collecting and placing in the hands of the planting community information at first hand as to the methods employed in cultivating and preparing Sea Island cotton. A full account of what was accomplished during this visit will be found in the *West Indian Bulletin*, Vol IV, p. 287. The Commissioner also obtained a large supply of the best seed from the Sea Islands for planting in the West Indies, and this has formed the chief original source of the seed from which Sea Island cotton is now grown in the islands.

At the request of the Government of Barbados, the Commissioner and Mr. Bovell took advantage of the opportunity afforded by this visit to obtain information respecting the trade in molasses and syrup.

With a view to following up the active steps already taken in previous years to encourage the sending of exhibits from the West Indies to the annual Exhibitions held in Canada, in August 1906 the Commissioner obtained permission from the Secretary of State for the Colonies to return to the West Indies from the United Kingdom, where he had been on duty leave, by way of Canada. He was thus enabled to attend the Exhibition at Halifax, and to take advantage of the opportunity of conferring with the official and other bodies interested in West Indian products.

In August of the following year (1907), the Commissioner of Agriculture again visited Canada, and was present at the Canadian National Exhibition at Toronto.

The West Indian Court at the Canadian Exhibition now attracts considerable attention, thereby tending to improve the trade relations between the Dominion and the West Indies.

The arrangements which the Commissioner of Agriculture was able to make during these visits have also resulted in the introduction into the West Indies of a large number of pedigree animals. Reference is made to this subject elsewhere in this article.

As has been indicated already, the Commissioner of Agriculture paid frequent visits to the United Kingdom in order to confer with the Colonial Office and others on matters relating to the agricultural interests of the West Indies.

INTRODUCTION OF ANIMALS FOR STOCK IMPROVEMENT.

Stud animals have been imported by the Imperial Department of Agriculture for the purpose of the improvement of stock in the West Indies. The plan followed was to receive the animals in Barbados, where they were kept for some time and transferred to the various islands for periods of different lengths. The details are as follows:—

Anglo-Nubian ram: presented by Baroness Burdett-Coutts and landed in Barbados in December 1902. Service fee 2s. From February 9, to June 15, 1903, in Barbados, he served fifty-three goats. Died in 1908.

Toggenburg goats: a ram and a ewe with two kids were purchased by Mr. O. Holmes Pegler in England and were landed in Barbados in April 1903. The ram kid was sent to St. Vincent.

Indian goats: two Punjab rams were imported from India in May 1905. One ram had to be killed; the services of the other have been utilized in most of the islands. Now in Barbados.

West African woolless sheep. Four of these animals were imported in September 1907. One was sold to St. Vincent and one to Barbados; the other two, after being used in the various islands, have died.

Small Stock. Besides the above-mentioned animals, this Department has imported and distributed at various periods small stock such as Belgian hares, fowls and ducks.

In addition to what has been done as mentioned above, the Department has assisted the various Governments in the selection, purchase and importation of stock for the farms under their control. Stock has also been purchased and imported out of lapsed balances of the Imperial Grants-in-aid to the several colonies. The maintenance and upkeep of these animals have been met out of Imperial funds. As it has been found no longer desirable for this Department to continue to purchase pedigree stock, it is now awarding bonuses for the importation of approved stud animals. under certain conditions.

The following paragraphs give the chief details of the efforts made toward stock improvement, by the Department, in the different islands.

BARBADOS. The general public has had the use of all the stud animals imported by this Department for, as has been stated, they were always landed in Barbados, kept for a certain time, and then put on service at a small fee in various parts of the island.

In 1910, two bonuses of £3 each were awarded for the importation of two Toggenburg rams.

GRENADA. A bonus of £25 was awarded in 1911 to the importer of a thoroughbred stallion into Carriacou.

Three bonuses of £3 each were offered for the importation of goats.

ST. VINCENT. The Department imported a Hereford bull in 1902 and kept the animal there on service until 1906, when it was transferred to Montserrat.

In 1905-6, the services of the Department were invoked to enable the Government of St. Vincent to administer funds at its disposal and available for the improvement of stock, and the following animals were imported : a stallion donkey from the United States of America, a thoroughbred horse, an Ayrshire bull and cow, and a Barbados cow.

ST. LUCIA. A shorthorn bull was imported from Canada in March 1902; it died in June 1902. In 1904, three cows and a Berkshire boar were also obtained from Canada, while in 1908 an Ayrshire bull was imported from the same country.

DOMINICA. A pony stallion, purchased originally for the Virgin Islands (see below), was transferred to Dominica in 1903. It was subsequently sent to Nevis (1906) and sold to a private owner in St. Kitts in 1907. Another horse used in Dominica was a cob stallion imported from Jamaica in 1901 and transferred to Montserrat in 1905. In 1961, the importation was also made of a donkey stallion from the United States, which was sent to St. Kitts in 1906. Pigs have comprised one Tamworth boar, and two sows of the same breed, imported from Trinidad in 1902, and two boars and two sows, all of the Poland-China breed, obtained from the United States in 1901. At the present time, two bonuses have been offered for the importation, respectively, of a donkey stallion and a horse stallion; the value of these is £25 and £20.

MONTSERRAT. The cattle imported have comprised a Devon and a Hereford bull; the former was obtained in 1904 from the Royal Farm, Windsor, and subsequently sold to a private owner in Anguilla, while the latter was transferred from St. Vincent, and sold to a private owner in Barbados in 1907. The cob stallion, which has already been mentioned as having been transferred to Dominica in 1905, died in 1908. In 1901 three Berkshire boars and the same number of Dorset rams were imported from the United States.

ANTIGUA. The importations of pedigree stock made by the Department for Antigua have been for the purpose of supplementing the efforts of the local agricultural department in maintaining an efficient stock farm. The animals obtained in this way have included the following: a donkey stallion and jennie imported from the United States in 1901; a donkey stallion imported from Jamaica in 1905 and transferred subsequently to Barbuda; a shorthorn bull imported from the Royal Farm, Windsor, in 1904, and another obtained from Canada; four Berkshire boars imported from the Royal Farm, Windsor in 1904, and three Tamworth boars from the Government Farm, Trinidad. A bonus of £50 is being offered at present for the importation of a donkey stallion into Antigua.

ST. KITTS-NEVIS. The animals obtained have included the following: donkey stallion imported in 1901, stationed in Nevis and sold in 1909 to a private owner; another donkey stallion, transferred from Dominica in 1906, which died in 1909; a Hereford bull imported in 1902, stationed in Nevis, and sold in 1908; an Ayrshire bull from Canada in 1906, died in 1907; a Shropshire ram in 1901 from Jamaica, died in 1906; six Berkshire boars from the United States and Canada, during the period 1901-6. The bonuses awarded have included three in 1909-10 - £20 for a horse stallion, £10 for a bull and £2 10s. for a boar pig. Bonuses of £50 each are now being offered for the importation of two stallion donkies.

VIRGIN ISLANDS. As has been stated, a pony stallion was obtained, and transferred to Dominica in 1903, the importation having taken place in the previous year. In 1906, two Yorkshire boars were imported for use in the Virgin Islands.

ENTOMOLOGY IN THE WEST INDIES.

A SUMMARY OF THE ENTOMOLOGICAL WORK UNDERTAKEN BY THE IMPERIAL DEPARTMENT OF AGRICULTURE DURING THE PERIOD FROM OCTOBER 1, 1898 TO MARCH 31, 1911.

I.

ORGANIZATION OF THE IMPERIAL DEPARTMENT OF AGRICULTURE AND THE APPOINTMENT OF ENTOMOLOGISTS.

The Imperial Department of Agriculture for the West Indies was organized in 1898, when Dr. (now Sir Daniel) Morris established the Head Office of the Department in Barbados on October 1 of that year.

It was not, however, until near the end of 1899 that any entomological work, as such, could be undertaken by the Department, when Mr. Harold Maxwell Lefroy, B.A., the first Entomologist on the Staff of the Department was appointed. He retained his office until the beginning of the year 1903, when he proceeded to India to take up his appointment as Imperial Entomologist to the Government of India. His successor, Mr. H. A. Ballou, M.Sc., assumed his duties on his arrival in the island of St. Kitts in March 1903, *en route* to headquarters.

II.

THE NEED OF AN ENTOMOLOGIST.

In the earliest correspondence between the Commissioner of Agriculture and the Colonial Office in connexion with the appointment of an Entomologist, this officer was referred to as a lecturer on economic entomology, and he was later mentioned as Economic Entomologist. The duties of this officer were outlined in a letter from the Commissioner to the Under Secretary of State for the Colonies, dated July 5, 1899, paragraph 2, as follows :—

'His principal duties will be to visit, give lectures and recommend suitable measures for the treatment of the numerous insect pests that are now so destructive to cultivated crops in the West Indies.'

In paragraph 4 of the same letter the following sentence occurs : —

'I am now however convinced that until the various scale and other injurious insects are properly treated, and fruit trees such as oranges, limes and mangos, as well as coffee, cacao and other plants yielding crops are capable of being kept free from disease, great loss will arise to cultivators in all parts of the West Indies.'

The following extract from a letter from the Secretary of State to the Governors of Barbados, British Guiana, Jamaica, Trinidad, Windward Islands and the Leeward Islands further expresses the need that was felt to exist at that time for a trained officer to advise in regard to injurious pests and diseases:—

'Specimens of diseased plants or of insect pests have occasionally been sent to this country for examination, but while such specimens are naturally on their arrival here not so suitable for examination as they would have been on the spot, the time lost in such a reference may be of serious consequence, nor would it be possible to meet the difficulty to any but a very small extent in this way.

'I have therefore come to the conclusion that there should be some officer in the West Indies possessing the requisite expert knowledge, whose duty it should be to advise the Government, as also individual planters and others, on this subject, and to deliver lectures from time to time under the direction of the Commissioner of Agriculture. It is accordingly proposed to appoint an Economic Entomologist who will be on the Staff of the Imperial Department of Agriculture, and whose salary and travelling expenses will be charged to the Imperial grant for that Department. The services of the Officer will, in the first instance, be available for the West Indies generally, but, should the demands upon his time hereafter prove more than he can meet, it will be necessary for the Governments of the larger Colonies, viz., British Guiana, Jamaica, and Trinidad, to provide for their own requirements in this respect.'

III.

THE DUTIES OF THE ENTOMOLOGIST.

The duties of the office as explained by the Secretary of State for the Colonies to Mr. Maxwell Lefroy previous to his accepting the appointment, were contained in paragraph 2 of a letter dated November 28, 1899, which reads as follows:—

'Your principal duties will be to visit the various West Indian Islands, to give lectures, and to recommend suitable measures for the treatment of the numerous insect pests which destroy cultivated crops in the West Indies. Your headquarters will be at Barbados, and while not on tour and giving lectures, you will be employed in preparing notes and recommendations for publication in the Bulletin of the Imperial Department of Agriculture and generally you will be required to place your services at the disposal of the Commissioner of Agriculture to be used in such manner as he may think fit.'

About three years later, the Imperial Commissioner explained the duties of the Entomologist to Mr. Ballou as follows:—

'The duties of the Entomologist require him to take charge of the laboratory and collections at the headquarters of the Department, to assist with correspondence relating to his work, to contribute articles to the *West Indian Bulletin* and the *Agricultural News* and take charge of all investigations and operations in the various colonies under the instructions of the Commissioner of Agriculture.'

It will thus be seen that, while the instructions laid down for the guidance of the Entomologists are substantially the same, slight modifications in expression indicate some changes that had arisen as the work progressed.

IV.

EARLY WORK IN ENTOMOLOGY.

Previous to the establishment of the Imperial Department of Agriculture, Botanical Departments had been formed in several of the West Indian Islands, and the officers of these Departments had accomplished a great deal in the study and treatment of fungoid diseases and insect pests.

In Jamaica there had been Entomologists at different times, in charge of the Museum of the Institute of Jamaica. Mr. W. Fawcett, B.Sc., Director of Agriculture, had considerable experience in dealing with the pests attacking the crops in that island. In Antigua, Mr. C. A. Barber, B.A., was for several years Superintendent of Agriculture. Mr. Barber, having been trained in biology, made valuable records of the insect pests of the Leeward Islands.

In Trinidad, Mr. J. H. Hart, Superintendent of the Botanic Station, was a keen observer of nature, and although he was originally trained as a botanist, many of his observations on insect pests are of interest and value.

In Barbados, Mr. J. R. Bovell, F.L.S., F.C.S., Superintendent of the Botanic Station, had acquired useful knowledge of the local insect pests.

In British Guiana, in addition to the Director of Agriculture, Professor J. B. Harrison, there had been a Curator of the Natural History Museum at Georgetown, and a considerable amount of information with regard to the insect pests of that Colony was on record.

At the first Agricultural Conference, held at Barbados in January 1899, Mr. J. R. Bovell read a paper entitled Field Treatment of the Diseases of the Sugar-cane in the West Indies. In this paper, mention is made of the epidemic of ants which in the eighteenth century threatened the sugar-cane industry on two different occasions in Barbados. Reference is also made to the following pests which are known to occur at the present time: the moth borer, the pink mealy-bug or white blight as it was called, the cane fly, the shot borer, and the weevil borer. Suggestions are given for the control of the moth borer, and the principal fungoid diseases were also discussed.

At the same Conference, Mr. Fawcett read a paper entitled The Prevention of the Introduction and Spread of Fungoid and Insect Pests in the West Indies, in which it was suggested that two methods should be adopted. One recommendation provided for the inspection of all nurseries by a botanist and entomologist who should have power to take such steps as were necessary to prevent the spread of any pest or disease on nursery stock, and another was that a law should be passed in every colony, by which the importation of seeds or plants liable to introduce any pest or disease might be prohibited.

At the Second Agricultural Conference held in Barbados, in January 1900, a paper entitled Bee-keeping in Jamaica was presented by Mr. James Doidge, Lecturer in Bee-keeping to the Jamaica Agricultural Society. At that Conference also, under the heading Legislation Suggested for the Treatment of Insect and Other Pests Affecting Economic Plants, the paper presented by Mr. Fawcett at the first Conference was discussed. A letter was read from the Secretary of State to the Governors of the several West Indian Colonies emphasizing the need of some means of control of pests and diseases of economic plants. Copies of the laws then in force in Jamaica, Trinidad and Tobago were discussed, and suggestions for a Plant Diseases Ordinance were brought forward.

V.

ENTOMOLOGY UNDER THE DIRECTION OF THE IMPERIAL COMMISSIONER AS REPRESENTED BY WEST INDIAN PUBLISHED ARTICLES.

At the time when Mr. Maxwell Lefroy assumed the duties of his office, the pests and diseases of sugar-cane were of so much importance that they naturally received first attention. The first problem, therefore, of any considerable proportion which gained the notice of the newly appointed entomologist was the moth borer (*Diatraea saccharalis*) of the sugar-cane.

At that time, the moth borer was considered to be the most serious insect pest of sugar-cane known in the West Indies. Although planters generally were familiar with the appearance of canes that had been injured by attacks of this pest, which had been associated with sugar-cane from the time of the earliest cultivation of this crop in the American tropics, comparatively few persons in these islands recognized the adult insect, or knew the life-history of this pest. The nature of the pioneer work in Entomology in connexion with the newly formed Department of Agriculture was therefore obvious. It was approached by Mr. Lefroy with much energy and prosecuted with much care, and as a result, valuable knowledge was obtained. In the *West Indian Bulletin*, Vol. I, p. 327, there appeared an article entitled Moth Borer of the Sugar-cane in which the results of the study of this first problem were presented. A general and historical account of the moth borer was given, and, perhaps for the first time, a complete account of the life-history, with descriptions of the egg, larva, pupa and imago, the duration of each stage of the insect's existence, the habits of egg-laying and the method of attack on the plant by the larva, were presented.

It was shown that the life-cycle occupies a period of about fifty days, that the eggs are laid on the leaves of the sugar-cane, and that the young larvae, almost as soon as hatched, travel down the leaves, and tunnel into the forming stem. In the course of these investigations, it was discovered that the eggs of the moth borer are attacked by a minute hymenopterous parasite (*Trichogramma pretiosa*), and a previously recorded observation that the larva is sometimes attacked by a fungus parasite (*Cordyceps barberi*) was confirmed. While it was realized that these natural enemies probably exert some influence on the numbers of the moth borer, it seemed very evident that additional means of control should be devised and carried out, if the ravages of the pest were to be further combated. The remedial measures recommended included the collecting of the eggs and the cutting out of dead hearts. An additional measure included the destruction of all infested canes at the time of reaping the crop ; those too seriously injured to be worth putting through the mill were recommended to be burned.

With the knowledge acquired during these early investigations, and as a result of the application of the remedial measures suggested, the moth borer came to be considered a much less important pest than formerly. It is likely, also, that the introduction of seedling canes, which have so largely replaced the old Bourbon variety, and are known to have a much harder rind or outer covering, has assisted greatly in reducing the injury from the moth borer.

Other insect pests of sugar-cane were investigated, and a brief account of them and of the injuries caused by them was presented to the West Indian Agricultural Conference in 1901, in a paper entitled Insect Pests of Sugar-cane, which was published in the *West Indian Bulletin*, Vol II, p. 41. The next extended investigation of the attack of an insect pest on a staple crop was that of thrips (*Physopus rubrocincta*) attacking cacao in Grenada An account of this was published in the *West Indian Bulletin*, Vol. II, p. 170.

Toward the end of 1900, the Entomologist visited Grenada to investigate a serious attack of thrips on cacao, in that island. These small insects injure the cacao, both leaf and pod, by their feeding, and it was supposed that the attacks of thrips were the cause of serious injuries to the trees, and of short crops. Investigation indicated, however, that while there was a relation between the presence of large numbers of thrips, and the forms of injury and loss already mentioned, it did not appear that thrips were entirely responsible as a cause ; but rather that they were present under those circumstances as one of the effects of the unpropitious conditions, although they may have contributed to the loss sustained by the grower and the damage suffered by the tree. The unfavourable conditions which were then thought to be largely responsible for the injury to the cacao trees and the shortage of crop were those relating to climate and soil. It was found in seasons of exceptional drought, and upon cacao estates where the drainage was poor, or where the cacao trees were insufficiently manured and otherwise uncared for, that thrips were more likely to be prevalent in large numbers than on estates where better agricultural methods were practised, or in more favourable seasons. Subsequent observations have very largely confirmed this idea, and at the present time it is generally recognized that a bad attack of thrips on cacao indicates that unfavourable conditions exist which it is wise to attempt to overcome by the improvement of soil conditions, by draining, manuring, and the addition of organic matter. Direct remedial measures were recommended by Mr. Lefroy, who carried out fairly extensive experiments in spraying, in Grenada. These measures, however, have not been generally adopted by cacao planters, probably because the cultural methods available have given good results in the control of this pest.

Another pest of sugar-cane which was investigated by the Entomologist was the lady-bird or weevil borer (*Sphenophorus sericeus*, Oliv.) of the sugar-cane, an account of which was presented to the West Indian Agricultural Conference of 1902 and published in the *West Indian Bulletin*, Vol. III, p. 88. The summary of the life-history and habits of this insect are given, together with the remedies suggested for its control. The first and most important of these was the thorough destruction of all rotten or infested canes, and while the other recommendations were valuable and practical, it is believed that this is the only one that has ever been extensively carried out by sugar-cane planters, and that it has been very largely influential in greatly reducing the amount of injury from this cause.

A valuable paper entitled Insect Control in the West Indies appeared in the *West Indian Bulletin*, Vol. II, p. 318. In the same volume of the *West Indian Bulletin*, a short article gave an account (p. 344) of the treatment of imported plants in Jamaica, and this was followed by one entitled Suggestions for Controlling Imported Insect Pests in the West Indies (Vol. III, p. 140). These papers were the first steps toward the development of the uniform system which has since been adopted in all the islands of the Lesser Antilles with the object of preventing the introduction of insect pests on imported plants.

Several short articles on entomological subjects appeared in Vol. III of the *West Indian Bulletin*, and these were followed by a good technical account of the scale insects of the West Indies, which appeared in two parts. Part I (p. 240) consists largely of a list of species of scale insects recorded as occurring in the West Indies, with many interesting and valuable notes on the food plants and habits of these insects. Part II (p. 295) contains an account of the West Indian scale insects under several headings. It is shown that in the West Indies Mr. Lefroy recognized, out of a total of 120 species, 80 which were native, 36 which were introduced, and 4 which were of doubtful origin. It is also noted that the species which occur as the more serious pests to cultivated crops, are among those that have been introduced rather than the native species.

In the *West Indian Bulletin*, Vol. III, p. 319, a paper by the Entomologist entitled Crude Oil and Soap, a New Insecticide, gave the results of experiments in the use of crude Barbados oil as a spray material against scale insects. A very satisfactory spray mixture was obtained by combining this oil with whale oil soap, by boiling them together with a small amount of naphthalene.

In 1903, a paper on The Root Borer (*Diaprepes abbreviatus*) of Sugar-Cane, prepared by the Rev. N. B. Watson of Barbados, was published in the *West Indian Bulletin* (see Vol. IV, p. 37). Although Mr. Watson was not an officer of the Imperial Department of Agriculture, this piece of work is mentioned here because it was published by the Department. Mr. Watson's paper included a description of the insect in its various stages, and gave very useful notes on its habits as a pest. At the time these observations were made, however, this insect was not recognized as a serious pest. Its occurrence in considerable numbers in 1909-10 and 1910 11 is referred to in the *Agricultural News*.

Mr. H. A. Ballou, M.Sc., assumed the duties of Entomologist to this Department on March 12, 1903, on which date he arrived in St. Kitts from New York, *en route* for headquarters. He reached Barbados on May 8, the intervening time being spent in visits to the Northern Islands. At that time, the question of the re-introduction of cotton cultivation into the West Indies was being considered by the Imperial Commissioner of Agriculture, and the first entomological work, therefore, for the new Entomologist was naturally to be found in connexion with the insect pests of cotton and the methods of control. Papers entitled Insect Pests of Cotton (*West Indian Bulletin*, Vol. IV, p. 268) and Insect Pests Attacking Cotton in the West Indies (*West Indian Bulletin*, Vol. IV, p. 326) were published during 1903-4. During this time, the insect pests which had attacked cotton in the West Indies were for the most part the same as, or closely related to, the pests known in the United States. The most serious of the American pests, the cotton boll weevil (*Anthonomus grandis*, Boh.), does not, however, occur in the British West Indies ; and another, the boll worm, which in certain parts of the Southern States is extremely abundant and injurious to cotton, has never occurred in destructive numbers in these islands.

In the first two or three years following the reintroduction of cotton into the West Indies, two new pests made their appearance. One of these, the leaf-blister mite (*Eriophyes gossypii*, Banks) of cotton, first attracted attention by its attacks, which resulted in the complete destruction of entire fields of cotton in Montserrat, in 1903. This pest has come to be known to have a very general distribution throughout the Lesser Antilles. It was first reported from Montserrat in 1903, and shortly afterwards was found in all the islands except Barbados, which up to the present time (1911) has been free from its attacks.

Another pest which, like the leaf-blister mite, was entirely new, was the red maggot (*Porricondyla gossypii*, Coq.) which occurred in Barbados as a pest of some importance, for two or three years. It has only once been reported as attacking cotton outside of Barbados, and then in Montserrat, in which place it has never occurred to any large extent.

At the West Indian Agricultural Conference held in Trinidad in 1905, several papers dealing with Entomological subjects were presented. These were chiefly reviews, and included The stseP Attacking Cotton (*West Indian Bulletin*, Vol. VI, p. 123), Sugar-cane (*ibid.*, p. 37), and cacao (*ibid.*, p. 94) in the West Indies. There was also a paper prepared and presented by the Entomologist on anthrax (*ibid.*, p. 156) which was of special interest at that time because of the occurrence of this disease among cattle on a fairly large scale in St. Vincent. An excellent account of the occurrence of anthrax in St. Vincent was presented and published, in connexion with that by the Entomologist, by Dr. C. W. Branch.

Early in 1906, a paper was published (*West Indian Bulletin*, Vol. VII, p. 40) entitled Notes on West Indian Insects, which included the results of an examination of West Indian Orthoptera from the collection of the Department by Mr. J. A. G. Rehn of the Academy of Natural Science, Philadelphia; notes on the butterflies of Barbados, and general notes, by Mr. Austin H. Clark of Boston, and a letter from Sir Gilbert Carter, Governor of Barbados, on the butterflies of Barbados. In addition to these there were general notes, added by the Entomologist, on several orders of insects.

At this time a paper on the cotton stainers was also published in the *West Indian Bulletin*, Vol. VII, p. 64. Cotton stainers had been the cause of considerable injury to cotton, and it was feared that they might prove serious pests. These insects belong to the genus Dysdercus, and although species of the genus have been known principally as pests of cotton for a good many years, there seems to have been no previous records of knowledge of life-history and of habits. The observations on which this paper was based extended over a considerable period of time, and were attended with many difficulties, principally on account of the fact that no cotton stainers at that time existed in Barbados, and all observations had to be made with imported specimens in captivity. It was necessary also to exercise the greatest care to prevent the escape of any of these insects, which might have led to the infestation of the cotton fields of Barbados. The paper already mentioned contained much information that was new, on the life-history and habits of cotton stainers, and it also presented a description of a new species from Grenada (*Dysdercus fernaldi*) and of a new species and new sub-species from Trinidad (*Dysdercus howardi* and *Dysdercus howardi*, var. *minor*). In Vol. VII of the *West Indian Bulletin*, there also appeared papers entitled Leaf-blister Mites (p. 337) and Insects as Carriers of Diseases (p. 86). These are reprinted from other publications and appeared as unsigned articles; they did not contain results of observations or investigations by officers of the Department.

In January 1907, the Agricultural Conference was held in Jamaica. Only a few of the papers prepared for this Conference were presented, on account of the earthquake which occurred during the meeting of the first day. A brief review of thrips attacking cacao, which was prepared as a Conference paper was published in the *West Indian Bulletin*, Vol. VIII, p. 143. A similar paper on the same subject was read before the Agricultural Conference in Barbados in January 1908, and was afterwards published in the *West Indian Bulletin*, Vol. IX; p 190. Another paper read before the Conference in Barbados in 1908 dealt with the treatment of cotton pests in the West Indies in 1907. In this connexion the probable usefulness of the native parasite (*Zalophothrix mirum*) of the black scale of cotton was first mentioned. For two or three years, the black scale was one of the most destructive pests with which cotton growers, especially in Barbados, had to contend. At the present time it has practically ceased to be a pest, and the change is attributed to the abundance of the parasite.

Toward the end of 1898, Mr. C. C. Gowdey, who was temporarily attached to the Imperial Department of Agriculture, prepared a paper on the Aleyrodidae of Barbados (*West Indian Bulletin*, Vol. IX, p. 445) which contained an account of all the recorded species of white fly from Barbados, giving descriptions of the several stages, habitat and food plants, together with several illustrations, some of which were prepared from drawings made by the author.

For several years a considerable amount of interest has been manifested in the West Indies in the relation that was supposed to exist between certain species of mosquitos and a small fish known as millions (*Girardinus poeciloides*), in Barbados. The statement had often been made in newspapers in different parts of the world, that Barbados owes its immunity from malaria to the presence of millions in the waters in the island which would naturally form breeding places for the malaria-bearing mosquito. This was supposed to be due to the fact that millions feed upon mosquito larvae, and are very efficient in preventing the breeding of mosquitos in any waters where they occur in abundance. A great many enquiries were received by the Imperial Commissioner of Agriculture with regard to the habits of this fish, their efficiency as mosquito destroyers, and also as to whether they could be shipped to other parts of the world where they might be used for stocking the water which served as breeding places for certain kinds of mosquitos. It was thought desirable to place on record the experience that has been gained in the studies of these small fish, and in the several attempts that had been made to introduce them into other localities. Consequently, an article entitled Millions and Mosquitos was prepared for the *West Indian Bulletin*, which appeared in Vol. IX, p. 382. There is no record to show that the malaria-bearing mosquito has ever been known to occur in Barbados, nor that any case of malaria in the human subject has ever been known to originate in this island, and consequently, it can hardly be said that the malarial mosquitos have been exterminated by millions; but there can be no doubt that millions are a most useful agent for the destruction of mosquito larvae, and that they can be successfully introduced into many localities where they are not at present known. It is not to be expected, however, that these small fish will ever completely exterminate any species of mosquito in any given district.

At the Agricultural Conference in Barbados, in January 1908, it was mentioned that a new insect pest attacking cotton had made its appearance at Antigua. This was a pest that has since come to be known as the flower-bud maggot (*Contarinia gossypii*, Felt), which belongs to the same group of insects as the red maggot, already mentioned as a pest of cotton in Barbados. This insect appeared at the end of 1907, causing the flower bud of the cotton plant to drop as the result of injury by the maggo of this very minute fly. The first attack lasted about thre months, that is until March 1908; a second occurred ove the same period at the end of 1908 and the beginning of 1909 These attacks resulted in a very great loss to cotton growers and were among the chief causes which led to the very considerable reduction of the area planted in cotton, in Antigua during the last few years. Both these attacks were investigated by the Entomologist, and the results of his observations published in the *West Indian Bulletin*, Vol. X, p.1, in an article entitled The Flower-bud Maggot of Cotton. No attacks by the flower-bud maggot had been recorded outside Antigua, although it has been reported as having occurred in Montserrat. The only remedy that can be suggested up to the present time for cotton growers in Antigua is early planting, which enables the cotton plant to develop sufficiently so that the first period of flowering shall be practically completed before that time of the year (November and December) when the flower-bud maggot makes its appearance.

For many years, sweet potatos in Barbados and other West Indian Islands have been, from time to time, seriously attacked by a small insect (*Cryptorhynchus batatae*, Waterhouse) known as the sweet potato weevil, scarabee or Jacobs, which tunnels in the ripening roots and often causes a very considerable loss in the crop. This insect was the subject of several experiments on a fairly large scale, and the results of these and an account of the insect itself, are published in a *West Indian Bulletin* paper entitled The Scarabee of the Sweet Potato (Vol. X, p. 180).

It is generally supposed by planters that the attacks of scarabee are more serious in dry seasons, and that their severity increases from year to year through a series of dry years. It is also supposed that the advent of rains serves as an efficient check to this pest.

No direct remedial measures have been found, that serve for the control of scarabee. It seems likely, however, from the observations already made that, by planting non-infested slips and by thorough destruction of potato vines and small roots immediately after the crop is harvested, the insect may be reduced to such comparatively small numbers that the attacks will cause a relatively small amount of loss in the crop. The attacks by scarabee will generally be much less severe if the potatos are harvested as soon as ripe, than if they are left in the ground for some time. Slips free from scarabee may be produced by planting small roots in a nursery away from potato fields. Uninfested roots should be planted, and slips taken, as soon as the vines have made sufficient growth.

As has already been intimated, early in the history of the Imperial Department of Agriculture it was realized that better provision was needed in the several colonies to prevent the introduction of insect pests and fungoid diseases in connexion with imported plants. The laws existing in the West Indies previous to the establishment of the Imperial Department provided for the total prohibition of the importation of plants when these were considered likely to be a means of introducing pests and diseases. The papers published in the early volumes of the *West Indian Bulletin*, to which reference has been made already, together with memoranda and statements of information with regard to imported plants, and the likelihood that these might be the means of the introduction of pests and diseases, served to aid the Governments of the several colonies in formulating laws for dealing with this subject. The Imperial Commissioner of Agriculture was very fully aware of the necessity for more efficient legislation for dealing with imported plants, and from the formation of the Department the subject was continually mentioned in official correspondence, until uniform legislation was provided in all the colonies.

It was not considered sufficient that it was possible to enforce the total prohibition of the importation of plants from any country where the prevalence of plant diseases or pests rendered it likely that these might be transported on or in plants, or parts of plants intended for propagation. It was deemed necessary that in each island it should be feasible to enforce such treatment of all imported plant material intended for propagation. The advice of the Entomologist was given with regard to the treatment of such plant material. He prepared plans for fumigating chambers and boxes which were sent out whenever they were desired, and suggestions were made as to the points that should be included in any Ordinance providing for the treatment of imported plants.

A paper entitled Legislation in the West Indies for the Control of Pests and Diseases of Imported Plants was published in the *West Indian Bulletin* (Vol. X, p. 19). This paper gives an account of the early laws dealing with imported plants and also presents those more recently enacted which provide a uniform system throughout the Leeward and Windward Islands, and Barbados. It was followed in the same volume of the *West Indian Bulletin* (p. 349) by one entitled The Disinfection of Imported Plants. It contains summaries of the laws in force in the West Indies, arranged for convenience of reference, together with directions for preparing and using insecticides and fungicides and general accounts of several of the principal of these.

A short paper entitled The Nomenclature of Scale Insects, (*West Indian Bulletin*, Vol. XI, p. 35) gives a list of the scale insects mentioned in the pamphlets already referred to (Scale Insects of the Lesser Antilles, Parts, I and II) for the purpose of comparing the technical and common names in use at the time of the publication of the pamphlets with certain revisions of the technical names that have been made since that time.

In a paper entitled Notes on Lime Cultivation (*West Indian Bulletin*, Vol. XI, p. 39), the preliminary results of experiments in the cultivation of limes are given, together with general notes on lime cultivation, with special reference to the prevalence of scale insects and other pests attacking this crop. The indications seem to be that under certain conditions too much surface tillage in lime cultivation is liable to be accompanied by a decided increase in the number of scale insects. In these notes, mention is made of the use of Bengal beans as a means of controlling scale insect attacks, and a brief account of the natural enemies of the scale insects attacking limes, both insect and fungoid, are given.

It has not been the practice of the Imperial Department of Agriculture to publish annual reports dealing with the insects prevalent during the year in the West Indies; but the insect pests and diseases for the year 1909-10 were reviewed in the *West Indian Bulletin*, Vol. XI, that portion of the article dealing with insect pests being presented at p. 85. This report is arranged for ease of reference both under the pests of the several crops and under the headings of the several islands of the Lesser Antilles.

While the Entomologist was on leave in the United States in 1910, he visited Florida for the purpose of studying the methods employed there in the control of the pests of citrus fruit, especially the use of parasitic fungi in controlling white fly and scale insects. The observations made during this visit were presented in a paper entitled Report on a Visit to Florida, which appeared in the *West Indian Bulletin*, Vol. XI, p. 172.

In the preceding pages, there is given an account of the work in entomology, as shown by the papers published in the *West Indian Bulletin*. The *Agricultural News* and the Pamphlet Series are intended to present information in a more popular form, and the more technical papers and papers of larger scope appear in the *West Indian Bulletin*. These, then, taken in chronological sequence, indicate the scope of entomological work and the principal problems that have come up for consideration during the past twelve years.

VI.

The *Agricultural News* has been the medium of communicating a very large amount of entomological information.

The first number of this periodical was issued on April 25, 1902, and the first volume was completed with No. 18, issued on December 20 of that year. Since that time, the volumes have coincided with the calendar years, nine volumes, including the numbers up to 226 having been issued up to the end of 1910. Vol. X (1911) is being issued. During this period the *Agricultural News* has been published regularly at fortnightly intervals, and, except in four numbers, there has always been some space devoted to entomological subjects.

At first this information was presented in short notes or articles inserted in diffierent places in the paper, but it was not long before these were assembled under the caption of Insect Notes and assigned a definite position in the publication. In most numbers of the *Agricultural News* a full page is devoted to Insect Notes, although this varies somewhat according to the matter to be presented, and may be more or less. The articles cover a great variety of subjects. For convenience of reference these may be grouped under three general heads: (1) abstracts of reports of entomological work, and of visits of the Entomologist; (2) information on topics of current interest, such as accounts of attacks of pests in the West Indies, abstracts of accounts of insects in the bulletins and reports of entomologists and agricultural departments in other parts of the world; (3) information of an educational character. Although they are unsigned, they are generally to be credited as the work of the Entomologist; those appearing in all the numbers up to and including No. 30 of June 6, 1903, were the work of Mr. Maxwell Lefroy. The first Insect Notes by the present Entomologist were published in No. 31, of June 20, 1903, and with few exceptions all those in the succeeding numbers have been prepared by him. These and other articles dealing with entomological subjects, which have not been the work of the Entomologist have been prepared editorially, except for those contributed by Mr. C. W. Jemmett and Mr. C. C. Gowdey, who were temporarily attached to the Staff of this Department. The information on topics of current interest has included facts with regard to the occurrence and prevalence of pests of cotton, cacao, sugar-cane, sweet potato and other crops, and pests of domestic animals. The occurrence of any new pest, or the unusual prevalence of any of those which are well-known, is generally recorded in the insect notes, together with suggestions for treatment and control. These notes have also been useful in furnishing a place where planters might be warned of the likelihood of the seasonal recurrence of pests of which the habits are recognized. The first record of the occurrence of the leaf-blister mite, the flower bud maggot, and the black scale (*Saissetia nigra* [*Lecanium nigrum*]) as pests of cotton, the account of the outbreaks of the root borer of sugar-cane, of the occurrence of cotton worm, and of scale insects on citrus trees are instances of this kind of information. The contents of the various reports and bulletins which are received from the Experiment Stations and Agricultural Departments in different parts of the world is abstracted and reviewed when they are likely to be of interest to the West Indian agriculturist, or when from the nature of the pests described it seems likely that similar troubles may be experienced in this part of the world.

One of the chief duties of the Entomologist has been the visiting of the several islands of the Lesser Antilles whenever his services have been requisitioned in connexion with any outbreak of insect pests, or when it has been thought advisable by the Commissioner of Agriculture, for the purpose of inspecting the plants at the Botanic Stations, and of giving advice generally in connexion with the pests of growing crops. These visits have furnished material for a considerable number of reports dealing with general and special subjects which have appeared more or less abstracted in the insect notes. Under the general subjects would be included the reports on the visits of inspection to the Botanic Station, and under the special subjects such reports as those prepared in connexion with the visits to Montserrat for the purpose of investigating the attacks of the leaf-blister mite, which made its appearance in that island in 1903; and to Antigua to investigate the occurrence of the flower-bud maggot in 1908 and 1909.

Information of an educational character, which has appeared in the insect notes, has been of a varied nature. Topics of this nature which have been discussed have included: insecticides, their nature, preparation, and directions for use; spraying apparatus and other appliances for the distribution of insecticides, and other various suggestions with regard to estate practice, calculated to reduce the severity of insect attacks. There have also been presented series of papers which have given a general outline of a course in elementary entomology, where such subjects as the orders of insects, the natural history of insects, and of their allies, the mites, the strength, number and size of insects, have been discussed. An article on popular names and one on moths and butterflies may also be included in the list of subjects giving information of an educational character.

VII.

ENTOMOLOGICAL PAMPHLETS.

There have been nine pamphlets either wholly or in part devoted to entomological subjects prepared by the Entomologists on the Staff of the Department, and one relating to bee-keeping, which was prepared by an officer temporarily attached to the Department. The first of these was No. 5 of the series, entitled General Treatment of Insect Pests. This was in issued in April 1901 and a revised edition on October 31, 1901. This pamphlet gave, in popular language, a brief account of the general treatment of insect pests, with directions for the preparation and use of insecticides, descriptions and illustrations of spraying apparatus, accounts of natural enemies and directions for collecting and forwarding specimens of insects for study and identification.

Two pamphlets dealing with the scale insects of the Lesser Antilles were issued as Nos. 7 and 22 of this series. No. 7, which forms the first part of the paper, was published in July 1901 ; No. 22, which formed part two of the paper was published on February 23, 1903. These give a very good account of fifty-one species of scale insects, with figures in most cases The life-history and structure, the distribution, and the injury done by these pests are treated in plain and simple language, and the nature and use of insecticides suitable for insects of this group carefully explained.

Pamphlet No. 14, The Screw Worm in St. Lucia, was issued on March 22, 1902. It contained a general account of the screw worm and of its occurrence as a serious pest in St. Lucia. Directions for applying remedial measures, and for the prevention of attack were given at some length. Pamphlet No. 9, entitled Bee-keeping in the West Indies, was issued on August 3, 1901. It was prepared by Mr. W. K. Morrison, who was temporarily attached to the Department during the first six months of that year. Mr. Morrison, who formerly belonged to the United States Department of Agriculture, came to the West Indies at the instance of the Imperial Commissioner of Agriculture, in order to give lectures and demonstrations in bee-keeping, and to indicate the possibilities of the establishment of a successful bee industry in these islands. In addition to the special information calculated to assist all who desired to take up bee-keeping, the pamphlet contains hints on bee-keeping specially applicable in the West Indies.

Pamphlet No. 31, which was issued on June 10, 1904, was entitled The A B C of Cotton Planting. The text was arranged in the form of simple questions and answers, by means of which it was intended to present the necessary knowledge to enable beginners in cotton-growing to deal with the difficulties which were likely to arise. Part III was devoted to the insect pests of cotton. Pamphlet No. 45, issued on February 11, 1907, was a revised and considerably enlarged edition of No. 31, the same method of question and answer in the presentation of the text being followed in this number also. Part III of this pamphlet was also devoted to insect pests, the information being thoroughly revised and greatly extended in order to include knowledge which had been acquired since the publication of the previous edition.

Millions and Mosquitos was the title of Pamphlet No. 55, which was issued on December 9, 1908. This contained an account of the small fish known in Barbados as Millions, which had been found to be an efficient destroyer of mosquito larvae. A general account was given of the fish and its larvae-eating habit, and also instructions for the successful transportation of millions to other parts of the world. The insect pests of cacao were dealt with in Pamphlet No. 58, which was issued on March 10, 1909. These pests were briefly reviewed for the purpose of making the information with regard to them easily accessible to those interested in cacao cultivation. The pamphlet was well illustrated, and directions were given for the use of such remedies as had been found to yield practical results.

LECTURES TO SUGAR PLANTERS.

A series of seven lectures was delivered at Barbados in 1902-3. A summary of these, uniform in size with the pamphlets, but not included as one of the series, was published toward the end of 1906. Lecture VI (pp. 123 52) was by Mr. Maxwell-Lefroy, on the Insect Pests of Sugar-cane and Associated Crops, and included accounts, with figures in most instances, of the principal pests of sugar-cane, corn and sweet potatos, which had appeared up to that time.

VIII.

VISITS OF THE ENTOMOLOGISTS.

It has already been stated that Mr Maxwell-Lefroy arrived in Barbados and assumed the duties of his appointment on December 24, 1899. It was not until following July that he found an opportunity to visit any of the other islands. At this time he proceeded to St. Kitts and Antigua to investigate the insect pests of sugar-cane. In September following he visited Grenada for the purpose of becoming acquainted with the general conditions of the pests in that island, and in December he returned to Grenada with the object of investigating an outbreak of thrips on cacao in that island In March 1901, a continued attack of thrips necessitated another visit to Grenada. A general visit to the Northern Islands in April and May of the same year included stops at Antigua, Dominica, and St. Lucia while a visit to Montserrat was made in August.

In September 1901 a severe outbreak of the arrowroot worm in St Vincent occasioned a visit by the Entomologist. Mr. A. Howard, who was then Mycologist on the Staff of the Department, visited St. Vincent in August 1900. A severe outbreak of the arrowroot worm (*Calpodes ethlius*) occurred at the time and Mr. Howard reported on it, making certain suggestions for its control. A second visit to Dominica was made by the Entomologist in October of the same year. In 1902 the screw worm of cattle became such a pest in St. Lucia that Mr. Maxwell-Lefroy's services were asked for, and he accordingly visited that island during February.

Mr. Lefroy proceeded to England on May 10, 1902, on leave, and on his return arrived in Barbados on August 30, via the United States where he had, with the sanction of the Imperial Commissioner, spent several days in visiting entomologists and entomological institutions, especially the Division of Entomology of the United States Department of Agriculture at Washington, D.C. Mr. Lefroy left Barbados for England on February 15, 1903, to proceed to India.

The present Entomolgist, Mr. H. A. Ballou, left New York on March 4, 1903, with instructions to proceed to St. Kitts where he landed on March 12. From this date until May 9, when he reached Barbados, he was occupied in travelling, visiting during this period St. Kitts, Nevis, Antigua, Dominica, Montserrat and St. Lucia, in the order mentioned. In Dominica, a severe attack of scale insects on lime trees was being experienced, and the Entomologist spent three weeks in that island investigating the occurrence, and advising as to remedial measures. The visits to the other islands at this time were not connected with the outbreak of any particular pest. but they afforded the Entomologist an opportunity of becoming acquainted with the conditions relating to the agriculture of each island, and of coming into contact with the planters and officers with whom correspondence in regard to crops and pests would be likely to be carried on. After remaining at Barbados for a few weeks, the Entomologist visited St. Vincent, with the general object of becoming familiar with the local conditions of agriculture, rather than for the purpose of investigating any particular pest. In September a visit was paid to Montserrat with the object of enquiring into an outbreak of leaf-blister mite of cotton, and another visit to the same island in connexion with the same pest was made in January 1904. In May of the same year, a visit was paid to Grenada, the object of which was similar to that to St. Vincent in the previous year, with the addition, however, that in Grenada at that time two entomological problems received more consideration than others. These were thrips on cacao, and black blight. In July following, the Entomologist went to the Northern Islands. His visit was of a general character, but the circumstances of the cotton cultivation were kept uppermost in mind, and it was hoped that it would be possible to give advice which would enable planters to be ready to combat any attack of pests on this crop. In September the Entomologist visited St. Lucia for the purpose of enquiring into the condition of the cotton industry, and of giving such information with regard to the culture and the treatment of the pests of this crop as would enable planters and others to deal successfully with it. In November a visit was paid to St. Vincent. This was largely for the purpose of aiding planters in dealing with the insect pests of cotton.

In 1905, the only visit by the Entomologist outside Barbados was a trip to Trinidad in connexion with the West Indian Agricultural Conference held in January of that year.

In 1906, the Entomologist was on vacation leave from May 9 to August 18; on the last-mentioned date he resumed duty in St. Kitts, *en route* to headquarters. The period from August 18 to October 2 was spent in travelling through the several islands, which were reached in the following order: St. Kitts-Nevis, Antigua, Montserrat, Dominica, St. Lucia. These visits were all general; but in those islands where cotton was grown special attention was given to that crop. In November, St. Lucia was visited in connexion with a reported outbreak of thrips in one district in that island, where large numbers of cacao trees were reported to be dying, as a result of thrips attack.

In January 1907, Jamaica was visited, in connexion with the West Indian Agricultural Conference. In March a visit was made to Grenada having special reference to the prevalence of scale insects and black blight in that island. Another general visit to the Northern Islands occurred during September and October of this year. At the end of 1907, the flower-bud maggot of cotton made its appearance in Antigua. In February 1908, and again in March, the Entomologist went to Antigua to investigate the outbreak of this pest, which assumed very serious proportions. During November and December of this year another general visit was made to the Northern Islands.

In January and February 1909, a visit was made to Antigua in connexion with the recurrence in that island of the flower-bud maggot. In March 1909, Montserrat was visited with special reference to scale insects attacking lime trees and the methods of control.

In March of 1910, another visit to Montserrat was made for the purpose of reporting on experiments with limes that were being carried out in that island, and with further reference to the control of scale insects on lime trees. The Entomologist was on leave in the United States from July 16 to November 12, during which time a period of fourteen days was devoted to travel on behalf of the Imperial Department of Agriculture. This included a visit to Washington, D.C., and to Florida, in which latter place a study was made of the control of scale insects and white fly on citrus trees by means of natural enemies.

A summary of the visits of the Entomologists to the different islands is presented in the following table:—

Year.	Grenada.	St. Vincent.	St. Lucia.	Dominica.	Montserrat	Antigua.	St. Kitts-Nevis.
1900 ...	..	...	...	...	...	Aug.	July
		Aug.	...	...	...	...	...
	Sep.	...	...	...	...	...	...
	Dec.	...	...	...	...	...	...
1901 ...	March	...	...	May	...	...	...
	...	Sep.	May	Oct.	Aug.	May	...
1902* ...	..	...	...	...	...	...	...
1903 ...	...	...	May	April	April	March	March
	...	June	...	...	...	...	...
	...	...	Sep.	Sep.	Sep.	...	...
	...	...	...	Dec.	...	...	...
1904 ...	...	...	...	...	Jan.	...	...
	May	May	...	...	...	...	...
	...	...	July	July	July	July	July
	...	...	Sep.	...	...	...	...
	...	Nov.	...	...	...	...	...
1905† ...	...	...	...	...	...	...	...
1906** ...	...	...	Sep.	Sep.	Sep.	Sep.	Aug.
	...	...	Nov.	...	...	...	...
1907 ...	March	...	...	...	Oct.	Sep.	Oct.
1908 ...	...	...	...	...	...	Feb.	...
	...	...	...	...	...	March	...
	...	..	...	Nov.	Nov.	Nov.	Nov.
1909†† ...	...	...	...	...	...	Jan.	...
	...	...	...	...	March	...	...
	...	...	Oct.	...	...	...	...
1910‡ ...	...	March	...	...	March	...	...

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*Lefroy on leave May 10 to August 30, 1902, resigned Feb. 15. 1903. Ballou assumed duty on March 2, 1903 St. Kitts.

†Trinidad Conference, Jan. 2-14.

**On leave May 10 to Aug. 18, resumed duty St. Kitts.

††Accompanied by C. W. Jemmett.

‡On leave July 16 to Nov. 12. (Washington and Florida, October.)

The amount of time spent in travel on duty by the Entomologists in the West Indies apart from the visits to estates in Barbados may be tabulated as follows:—

1900	53 days.	
1901	59 „	
1902	11 „	
1903	59 „	
1904	64 „	
1905	13 „	
1906	46 „	
1907	60 „	
1908	90 „	
1909	51 „	
1910	22 „	(includes 14 days duty leave in the United States.)
	528 days.	

Absent from Barbados on vacation leave,

1902	123 days.
1906	102 „
1910	120 „
	345 „
Less duty leave	14 „
	331 days.

Total absence from Barbados 528 + 331 = 859 days.

IX.

Correspondence, etc., and Work of Local Officers

It has been the duty of the Entomologist to deal with all matters relating to entomology which have come up for consideration in all the islands where the Imperial Department of Agriculture has exercised the control and direction of agricultural effort. This has involved attention to correspondence relating to this line of work, the examination of insect specimens which have, from time to time, been forwarded to the Head Office, either because of their attacks on cultivated crops, or because they seemed likely to be of general interest. A collection of insects has been formed at the Head Office, and the arrangement and care of the specimens in this collection have been included in the responsibilities of the Entomologist. He has also been required to advise as to the treatment of any insect pests which have been reported, and to suggest lines of experiment which might demonstrate measures of control in the case of pests which were new, and in that of those for which no remedies had been found previously. Systematic collections of scale insects extending over a considerable period of time have been made, the actual work of collecting having been largely done by officers of the local Departments, and the examination of the material collected carried out by the Entomologist at the Head Office.

In a similar manner, observations on the prevalence of scale insects and other pests have been carried out in the several islands by local officers and others, and the results forwarded to the Head Office for record, and for the purpose of collection.

The identification of specimens is often work for specialists, and many specimens have been forwarded to Museums and Institutes, where specialists on the several groups of insects are stationed. Among the institutions to which material has been sent for identification may be mentioned: the British Museum (Natural History), the Bureau of Entomology of the United States Department of Agriculture, the United States National Museum, the Academy of Natural Science at Philadelphia, the New York State Museum at Albany, the American Museum at New York, the Massachusetts Agricultural College, and the Boston Museum of Natural History.

A very considerable amount of time is necessarily occupied by the work outlined in the foregoing paragraphs. The receiving, recording and examining of the material forwarded to the Head Office, the correspondence involved in replying to enquiries and suggesting treatment of pests, planning lines of experiments and collecting results, the preparation of insects for the Department collection, and the care which has to be exercised in order to preserve the collection in a satisfactory condition, and the preparation of insect material to be sent away for study by specialists, are all matters that make large demands on the time of the Entomologist, and the extent of the time spent in this manner is not indicated in the papers and articles that appear in the Department publications. It will be seen, however, that although much of this work is in the nature of routine, it has a considerable bearing on the final results, and is of much value in keeping the Department in touch with the local officers and agriculturists throughout the West Indies, and with scientific institutions in other parts of the world.

The value of this portion of the entomological work can hardly be overestimated. The visits of the Entomologist to the several islands enable him to keep in touch with the existing conditions from time to time, and the publications of the Department provide for the dissemination of general and special knowledge but the most intimate communication between agriculturists and the Entomologist is possible only through the medium of the local officers. They receive specimens of, and enquiries with regard to, pests, and forward them to the Head Office. The best information available is returned to them and by them imparted directly to the planters and others for whom it is intended. The local officers represent the Department and serve as its agents, not only in adminstering the affairs of their respective stations, but also in distributing the special knowledge available to them by virtue of their relation with the Head Office. Their usefulness is thus greatly increased and the work of the Officers on the Staff of the Imperial Department of Agriculture applied much more directly to practical affairs.

This work appears to a certain extent in the Annual Reports of the Botanic and Experiment Stations, in the form of notes on the insect pests of the year as part of the work of the local officers, but is hardly to be seen reflected in the publications of the Entomologist. It is one of the invisible but very strong lines of activity operating for the benefit of the agriculture of the islands. That this work is appreciated is indicated by the readiness with which planters submit their insect pest problems to the local officers and thus to the Head Office, for advice. The correspondence from a central office, and the publication of information by a central scientific staff serve to correlate observations, and to place the experiences of all the islands within the reach of the individual planters in each of them.

It has also been customary for the Entomologist to prepare reviews of books relating to entomology, especially when these have a direct bearing on the work of this Department, or when they are likely to be of interest to West Indian readers of the *Agricultural News*. The Entomologist has also occasionally contributed editorial articles for publication in the *Agricultural News*.

During a period of about two years (1907 9), owing to pressure of work at the Head Office, and the illness of the Scientific Assistant, the time of the Entomologist was very largely taken up with work in connexion with the issuing of the publications of the Department. It has also been necessary, from time to time, for the Entomologist to deal with biological problems other than those which are entomological, because no officer especially trained for dealing with such problems has been available at the time. An example of this is to be found in connexion with the outbreak of anthrax in St. Vincent.

X.

ENTOMOLOGISTS TEMPORARILY ATTACHED TO THE STAFF OF THE IMPERIAL DEPARTMENT OF AGRICULTURE.

In addition to the two Entomologists who have been regularly appointed on the Staff of this Department, there have been several who were temporarily attached for one purpose or another. They will be considered here briefly, in order, according to the dates at which they have taken up such connexion with the Department in Barbados.

The first of these was Mr. W. K. Morrison, an expert in bee-keeping, who was formerly connected with the United States Department of Agriculture. Mr. Morrison visited, between January 1 and June 1901, the following islands in the order named: Barbados, Dominica, Montserrat, Antigua, Grenada, St. Vincent, St. Lucia, and after each visit prepared a report on the condition and prospects of bee keeping in each island, which was published in the *Official Gazette* and distributed for general information. Mr. Morrison also prepared a pamphlet on bee-keeping in the West Indies, which was issued as No. 9 of the Pamphlet Series (August 1901) of the Department. This pamphlet gave a very concise and complete account of the principles of bee-keeping, and was well illustrated with cuts which are intended to assist the beginner to understand the descriptions given in the text.

Dr. R. Hamlyn-Harris, D.Sc., F.E.S., F.Z.S., F.R.M.S., was temporarily attached to the Staff of the Imperial Department of Agriculture, as Honorary Assistant Entomologist, from October 10, 1902, to January 31, 1903. Dr. Harris was a specialist in the order Hymenoptera, and had some knowledge of bees and bee-keeping.

Mr. C. W. Jemmett, of the Wye Agricultural College, Kent who has been appointed Government Entomologist for Southern Nigeria, was temporarily attached to the Staff of the Imperial Department of Agriculture from September 14, 1908 to March 9, 1909. It was one of the conditions of Mr. Jemmett's appointment that he should visit the West Indies before proceeding to Southern Nigeria, and under the direction of the Imperial Commissioner, make himself as familiar as possible with the conditions of practical entomology as applied to tropical agriculture Mr. Jemmett's stay in the West Indies extended over a period of about six months, during which time he made a study, under the immediate supervision of the Entomologist on the Staff of the Department, of the insects which occur as pests of agricultural crops in the West Indies. Mr. Jemmett also accompanied the Entomologist on a tour through the Northern Islands, from October 30 to December 5 visiting Antigua, St. Kitts, Nevis, and Dominica, where he had an opportunity of becoming acquainted with the circumstances of the cultivations of the principal crops in those islands. Mr. Jemmett prepared the Insect Notes which appeared in the *Agricultural News*, Vol. VIII, p. 12, entitled Some Beneficial Insects, and Vol. VIII, p. 71, entitled Some Parasites of the Cotton Worm. He left Barbados for England on March 9, 1909, preparatory to taking up the duties of his appointment in Southern Nigeria.

Mr. C. C. Gowdey, who graduated in entomology at the Massachusetts Agricultural College in June 1908, was for a few months, at the end of that year, attached in an honorary capacity to the Imperial Department of Agriculture, as an additional Entomologist. During the time that Mr. Gowdey was attached to the Staff of the Department he made a study of the Aleyrodidae of Barbados, and prepared a paper which was published in the *West Indian Bulletin*, Vol. IX, p. 345. This account dealt with all the species of this group of injurious insects known at that time to occur in Barbados. Descriptions of the several species were given, with two plates from drawings prepared by Mr. Gowdey, and analytical keys to assist in the indentification of any members of this family which it might be desired to determine.

In this connexion it might be well also to mention the Rev. N. B. Watson, F.E.S., Vicar of St. Martins, Barbados. Mr. Watson is an ardent naturalist who, acting entirely on his own initiative, has worked out the life-history of the root borer of the sugar-cane, and prepared a paper which was published in the *West Indian Bulletin*, Vol. IV, p. 37. Mr. Watson also assisted the Department with entomological advice during the absence on leave of the Entomologist in 1910.

In concluding the consideration of this part of the work of the Department, it is necessary to express full appreciation of the assistance rendered by the officers of the local Departments of Agriculture of the several islands. These officers have always been very ready to aid in all investigations and experiments connected with the control of insect pests, and it is greatly due to their observations that the large amount of valuable information on this subject has been accumulated at the Head Office of the Department.

XI.

THE ENTOMOLOGISTS AND THEIR QUALIFICATIONS.

Harold Maxwell-Lefroy, M.A., F.E.S., F.Z.S. First Class in Natural Sciences Tripos, Cambridge, 1898. Assistant Master, Seaford College, Sussex. Appointed Entomologist on the Staff of the Imperial Department of Agriculture December 13, 1899. Resigned February 15, 1903, to take up appointment as Entomologist to the Government of India.

Henry Arthur Ballou, B.Sc., Massachusetts Agricultural College, 1895. M.Sc. (M.A.C.) 1906. Connected with the Entomological Laboratory Gipsy Moth Commission of Massachusetts 1895; Assistant Professor of Botany and Entomology, Connecticut Agricultural College 1897-1901. In residence at the Massachusetts Agricultural College as post graduate student in Entomology and Botany 1901-3. Appointed Entomologist on the Staff of the Imperial Department of Agriculture March 4, 1903.

W. K. Morrison. Expert in Bee-keeping, formerly attached to the United States Department of Agriculture; temporarily attached to the Imperial Department of Agriculture, January 1 to May 10, 1901.

R. Hamlyn-Harris, D.Sc., F.E.S., F.Z.S., F.R.M.S. Temporarily attached to the Staff of the Imperial Department of Agriculture as Honorary Assistant Entomologist from October 10, 1902, to January 31, 1903.

Charles W. Jemmett. Wye Agricultural College, Kent. Temporarily attached to the Staff of the Imperial Department of Agriculture from September 14, 1908, to March 9, 1909, for the purpose of studying entomological problems in connexion with tropical agriculture, under the direction of the Imperial Commissioner. Mr. Jemmett left Barbados on March 9, 1909, to proceed to Southern Nigeria to assume the duties of his substantive appointment as Government Entomologist.

Carlton C. Gowdey, B.Sc., Massachusetts Agricultural College 1908. Temporarily attached to the Imperial Department of Agriculture in an honorary capacity as Additional Entomologist from September 23 to December 19, 1908, when he left Barbados to take up the duties of his new appointment as Government Entomologist to the Protectorate of Uganda.

XII.

A RÉSUMÉ OF THE ENTOMOLOGICAL POSITION.

It may be advisable at this point to present a comparison between the position with regard to the entomological knowledge in the West Indies at the time that the Imperial Department of Agriculture was organized, and at the present time after a period of twelve years has elapsed.

In 1898, when the Imperial Department of Agriculture first began its work in the West Indies, three principal crops were recognized as the foundation of West Indian agriculture. These were sugar, cacao and limes. The precarious condition of the sugar industry was largely the cause of the action of the Imperial Government in establishing the Imperial Department of Agriculture for the West Indies. This precarious condition was partly due to the ravages of insect pests and fungoid diseases which threatened the very existence of the sugar industry.

THE EARLIER PESTS.

The insect pests which took such an important part were recognized, and many of them had been studied to a certain extent. They were, as has already been stated, the moth borer, the weevil borer, the cane fly, the shot borer and the pink mealy-bug. The knowledge of these pests, however, was not complete. During the first years of the existence of this Department much more definite knowledge of the life-history and habits of these insects was placed upon record as a result of the work of the Entomologists on the Staff of the Department.

During this time thrips, as a pest of cacao of considerable importance, made its appearance in several of the cacao-growing islands, and a large amount of information with regard to it was placed on record. Bee-keeping also received attention under the auspices of the Department, and the information made available in this connexion greatly assisted in the development of a profitable minor industry in several islands. Pests of sugar-cane, such as the root borer, and of cacao, such as the cacao beetle, were studied, and information with regard to their habits and the control measures to be employed against them was made available to the planters through the medium of departmental publications.

Scale insects, which are such important pests of agricultural crops throughout the West Indies, have received a great deal of attention, and the results have been published by the Department.

NEW PESTS.

The re-establishment of the cotton industry naturally brought to notice many pests, which previously had been entirely unknown to West Indian agriculturists. Some of these were well known in cotton-growing districts elsewhere, and it was merely necessary to inform the West Indian cotton growers as to the characteristics and their habits and behaviour under West Indian conditions, and also to instruct planters and others as to the best methods to adopt for their control. The principal of these are: the cotton worm, cotton stainers, the boll worm and the cotton plant louse. On the other hand, several pests of cotton, which were new to science and have never been recorded from any other part of the world, have made their appearance in the West Indies. The new pests of cotton which have developed in the West Indies are the leaf-blister mite, the red maggot, and the flower-bud maggot, all of which have occurred at times, and in certain localities, as pests of major importance to the cotton industry.

Pests, which have been known in connexion with other plants in the West Indies, and which have adapted themselves to the cotton plant because of the rapid increase in area devoted to this crop are: the black scale, the white scale, and cut worms. Of these, the black scale has been by far of the greatest importance.

BENEFICIAL INSECTS.

Many insects which have probably occurred in the West Indies for many years and are now recognized as beneficial to the planter from their habits of being parasitic within, or predaceous upon, other insects, have been brought to notice, and their value recognized within the last few years. Mention might be made of the minute egg parasites which destroy large proportions of the eggs of the moth borer and of the cotton worm, and a considerable number of species parasitic on scale insects, and at least two species which are parasitic in the bodies of the cotton caterpillars; of the lady-bird beetles of several species which feed upon plant lice and scale insects; of the Jack Spaniards and other wasps which feed upon the cotton worm and other caterpillars; and of the ground beetles which also attack several different kinds of caterpillars.

It may be well to note that one of these beneficial insects, which has played a most important part in the control of a very serious pest, is a species new to science, which was discovered by officers of this Department. This is the parasite of the black scale attacking cotton, which was identified by a specialist, Mr. J. C. Crawford, attached to the United States Department of Agriculture, and given the name *Zalophothrix mirum*. This insect has controlled the black scale, which in 1905 was the most serious pest of cotton in Barbados, so as to reduce it to such an inconspicuous condition that cotton planters in that island have ceased to regard it as an enemy of importance.

CULTURAL METHODS.

With regard to thrips, which at one time was considered a serious pest of cacao, it is now recognized that cultural methods which keep the trees in the best possible condition of vigour are generally sufficient for the satisfactory control of this insect.

MILLIONS.

A considerable amount of work has also been done, with reference to the use of a small fish known in Barbados as Millions, for the control of mosquito larvae in stagnant and slow-running water, and consignments of these fish have at different times been forwarded to localities in other parts of the world.

LEGISLATION.

Attention has also been given to the matter of legislation for the prevention of the introduction of insect pests and diseases on imported plants, with the result that each island in the Lesser Antilles now has satisfactory legislation bearing upon this subject.

INSECTICIDES.

Insecticides of all sorts have received attention, and the West Indian agriculturist can, by referring to the various publications of the Department, learn exactly which substance to apply, and how to apply it, for the control of any pest attacking any of the principal crops or plants. The papers in the *West Indian Bulletin* entitled Scale Insects in the West Indies, Parts I and II, and the two Pamphlets entitled Scale Insects of the Lesser Antilles, Nos. 7 and 22, give excellent technical and general accounts of these troublesome insects. More recently, experiments have been carried out with reference to the scale insects of particular crops, and investigations have been undertaken for the purpose of providing more exact information as to the periodicity in the life-cycle of scale insects, and as to the influence of their natural enemies as a means of control.

In Montserrat, experiments with the effect of cultural methods on the control of scale insects attacking limes have given preliminary results which seem to be of considerable importance. For a period of over a year, more or less regular collections of scale insects were made by the local officers, and the collected material forwarded to the Head Office for examination. The object of this line of investigation was to acquire more definite knowledge with regard to the natural enemies of scale insects, in the hope that some use of these might be made under artificial control. Several new parasites have been found during these investigations, and these will probably be continued for a further period. Observations on scale insects have also been made at regular intervals in nearly all the islands of the Windward and Leeward groups, and Barbados. It was hoped that these observations would indicate the times at which the newly hatched young are most prevalent, and also the times at which the natural enemies of the scales occur in greatest abundance.

PROBLEMS STILL TO BE WORKED OUT.

Among the pests that have long been known in the West Indies, and which require a considerable amount of study in order that the best methods of control may be demonstrated, there may be mentioned the scarabee of the sweet potato, cattle ticks, and the root borer of the sugar-cane. The scarabee of the sweet potato has been the subject of some study and experiment, but much still remains to be done. The nature of the attack by this insect on the underground portions of the plant, and the peculiar conditions under which sweet potatos are grown in most parts of the West Indies, make it necessary that experiments extending over a considerable period of time and over a large area should be carefully carried out. Cattle ticks have been the subject of extended study in many other parts of the world, and if they should become of sufficient importance to make it necessary for control measures to be adopted on a large scale, it is likely that methods which have been found successful in other places might readily be adapted to West Indian conditions. The root borer of the sugar-cane has occurred as a pest in Barbados for the past two seasons, 1909-10 and 1910-11, and no systematic attempts to devise methods of control have as yet been recorded.

OCCURRENCE OF THE COTTON WORM.

It should perhaps be mentioned in this relation that there are extremely peculiar conditions to be noticed in connexion with at least two of the principal pests of cotton. The cotton worm, which is supposed to be a native of tropical America, occurs in all the West Indian Islands. In Barbados and certain other islands, planters have been put to a very great expense for Paris green and London purple for the control of this pest, but in St. Vincent it has never been necessary to apply insecticides for the control of the cotton worm, as a part of estate practice. The cotton worm is known to occur in St. Vincent, but its natural enemies exert such a complete control over it that it does not increase in numbers sufficiently to be regarded as a pest. The greatest amount of credit for this control is given to a wasp which is known in St. Vincent as the Jack Spaniard (*Polistes annularis*). This species and kinds closely related are known to prey upon the cotton worm in other islands, as well. In Barbados and the other islands, cotton planters have enjoyed comparative immunity from the attacks of the cotton worm for a period extending over the past two growing seasons.

DISTRIBUTION OF LEAF-BLISTER MITE.

Another remarkable feature in the occurrence of pests is to be found in connexion with the distribution of the cotton leaf-blister mite. This minute mite made its appearance in 1903, first in Montserrat and afterwards in all the islands of the Lesser Antilles, except Barbados. The wild food plants of this pest are not known, but it is found that the so-called wild cotton is attacked to some extent. It is not possible, therefore, to say what plant is missing from the flora of Barbados which is responsible for harbouring this mite in the other islands. It is to be noted, however, that in all the islands where leaf-blister mite attacks cotton, Acacia is attacked by a species of leaf-blister mite similar to, but distinct from, that attacking cotton, and that in Barbados where cotton is not attacked by the leaf-blister mite, no leaf-blister mite has yet been found attacking Acacia. All experiments which have, so far, been tried for the purpose of infecting cotton, grown under conditions of control, with the leaf-blister mite on Acacia have given negative results.

CONCLUSION.

In concluding this résumé of the entomological position in the West Indies, it may be of interest to mention the relation in which practical agriculturists stand to the entomological work of the Department. At the present time, planters and others would seem to recognize fully the value of a knowledge of insect pests from a practical point of view. They are for the most part much more observant of the injuries to their crops than they were at the time when the Imperial Department was established. They are more ready to undertake lines of experiment with the object of controlling insect pests, and they have, in the past few years, become more familiar with the use of insecticides; they recognize to a greater extent the value of cultural methods and established practice which result in the destruction of diseased and useless plants, and, where these are known, of the removal of the wild food plants of insects which attack cultivated crops.

There would seem to be no doubt that this improved condition of affairs has been largely brought about as a result of the work of the Imperial Department of Agriculture.

The publication of Insect Notes in the *Agricultural News*, and of the pamphlets, both of which contain information in popular language, and the dissemination of more technical knowledge by means of articles in the *West Indian Bulletin*, have placed within the reach of all a much wider knowledge than ever before. Not only is this knowledge available to those who read the publications of the Department, but it possibly reaches many who do not; for this information is disseminated by the local officers in each island in general conversation and in remarks and discussions at the meetings of the Agricultural Societies. These officers also are kept informed by means of correspondence with regard to many details, and the information thus acquired by them is transmitted to the others in each island who are most interested.

The agriculturist thus has a much wider general knowledge, and a ready and easy means of communication whereby he may be quickly informed with regard to any new trouble which may arise. Planters are more ready than ever before to avail themselves of these opportunities, and to consult the officers of the local Departments and of the Head Office.

XIII.

ENTOMOLOGICAL PAPERS IN WEST INDIAN BULLETIN, VOLS. I TO XI, AND PAMPHLETS.

WEST INDIAN BULLETIN.

Field Treatment of the Diseases of Sugar-Cane in the West Indies. By J. R. Bovell, F.L.S., F.C.S.
Vol. I, Part 1, p. 33, July 1, 1899.

Moth borer	(*Diatraea saccharalis*, Fabr.).
Pink mealy-bug	White blight (*Pseudococcus calceolariae*, Mask.).
Cane fly	Black blight (*Delphax saccharivora*, Westwood.).
Shot borer	(*Xyleborus perforans*, Woll.).
Weevil borer	(*Sphenophorus* [sacchari] *sericeus*, Oliv.).

Fungoid diseases were also discussed.

The Prevention of the Introduction and Spread of Fungoid and Insect Pests in the West Indies. By The Hon. W. Fawcett, B.Sc., F.L.S.

Vol. I, Part 1, p. 133, July 1, 1899.
Coffee leaf disease in Ceylon.
Suggestions.
Nursery inspection.
Fumigation of imported plants.

Bee-keeping in Jamaica. By James Doidge.

Vol. I, Part 4, p. 305, June 1, 1900.

Legislation Suggested for the Treatment for Insect and Other Pests Affecting Economic Plants. Vol. I, Part 4, p. 309, June 1900.

Discussion of Mr. Fawcett's paper.
Letter from the Secretary of State.
Laws.
Jamaica.
Trinidad and Tobago.
Suggestions for Plant Diseases Ordinance.

Fumigation of Seeds and Plants. Vol. I, Part 4, p. 457, October 1, 1908.

Extract from Reports.
Director of Royal Botanic Gardens, Ceylon, 1899.
Government Entomologist of Cape of Good Hope, 1899.
Memorandum by Mr. Maxwell-Lefroy.

Insectivorous Birds. Vol. II, Part 3, p. 241, October 15, 1901.

Bee-keeping in the West Indies. Vol. II, Part 4, p. 285, February 15, 1902.

The Moth borer of the Sugar-Cane (*Diatraea saccharalis*, Fabr.). By H. Maxwell-Lefroy, B.A.

Vol. I, Part 4, p. 327, October 1, 1900.
Historical Account.
Description of stages (with figures)
Parasites.
Injury.
Remedies.
Bibliography.

Insect Pests of Sugar-cane. By H. Maxwell-Lefroy, B.A., F.E.S.

Vol. II, part 1, p. 41, March 1, 1901.
Moth borer (*Diatraea saccharalis*, Fabr.).
The lady-bird borer (*Sphenophorus sericeus*, Oliv.).
The cane fly (*Delphax saccharivora*, Westwood).

Thrips on Cacao Trees. (*Heliothrips* [Physopus] *rubrocincta* Giard.)

By H. Maxwell-Lefroy, B.A., F.E S.

Vol. II, Part 3, p. 175. October 15, 1901.
Reports of visits to Grenada, December 1900 and March 1901.
Account of the Insect (with figures).
Nature of attack.
Severity of attack.
Experiments in spraying.
Suggested remedies.
Appendix containing recipes for spraying mixtures, with cost, and cost of treatment of infested cacao cultivations.

Thrips on Cacao in Guadeloupe.

Vol. II, Part 4, p. 288. February 15, 1902.

Suggestions for Insect Control in the West Indies.

By H. Maxwell-Lefroy, B.A., F.E.S.

Vol. II, Part 4, p. 318. February 15, 1902.
Quarantine and Fumigation of Dangerous Imports.
Preventive measures.
Remedial measures.
Protection of useful birds and other animals.
Introduction of beneficial birds, insects, etc.

Treatment of Imported Plants at Jamaica.

Vol. II, Part 4, p. 334. February 15, 1902.

Ants in Relation to Plants.

Vol. II, Part 4, p. 346. February 15, 1902.
Miscellaneous Notes. Destruction of Mole Crickets.
Vol. II, Part 4, p. 349. February 15, 1902.

The Lady-bird or Weevil Borer of Sugar-cane. (*Sphenophorus sericeus.* Oliv.)

By H. Maxwell-Lefroy, B.A., F.E.S.

Vol. III, Part 1, p. 88. May 10. 1902.
Life-history.
Mode of attack.
Remedies.

Suggestions for Controlling Importations of Insect Pests.

By H. Maxwell-Lefroy, B.A., F.E.S.

Vol. III, Part 2, p. 140. August 2, 1902.
Introduced pests.
Pests liable to be introduced.
Spread of pests from colony to colony.
Scale insects and other pests.
Imports.
Dangerous imports.

Insect Epidemics.
Vol. III, Part 3, p. 233. November 8, 1902.

Green Page Moth. *Urania* [Cydimon] *leilus.*
Vol. III, Part 3, p. 236. November 8, 1902.

The Guinea Grass Moth. (*Remigia repanda,* Fabr.)
Vol. III, Part 3, p. 238. November 8, 1902.

The Scale Insects of the West Indies.
By H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S.
Vol. III, Part 3, p. 240. November 8, 1902.
Introduction.
Literature.
List of species.

The Scale Insects of the West Indies.
By H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S.
Vol. III, Part 4, p. 295. March 14, 1903.
Native and introduced species.
Species likely to be introduced to foreign countries from the West Indies.
Wild and cultivated species.
Coccids and ants.
Habits.
Food plants.
Males.
Enemies.
Predators and parasites.
Diseases.
The place of Coccidae among economic insects.
Plant species.
Control.

Crude Oil and Soap. A new Insecticide.
By H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S.
Vol. III, Part 4, p. 319. March 14, 1903.
A mixture of whale oil soap, crude Barbados petroleum and napthalene.

The Root Borer of the Sugar-Cane. (*Diaprepes abbreviatus,* Linn.)
By the Rev. N. B. Watson.
Vol. IV, Part 1, p. 37. April 25, 1903.
Description of the egg, larva, pupa, imago.
Summary of life-history.
Remedial measures.
Food plants.

Insects attacking Cotton in the West Indies.
By H. A. Ballou, B.Sc.
Vol. IV, Part 3, p. 268. December 5, 1903.
Cotton worm (*Alabama* [Aletia] *argillacea,* Hübn.)
Cotton boll weevil (*Anthonomus grandis,* Bon.).

Cotton boll worm (*Heliothis* [armiger] *obsoleta*, Hübn.)
Cotton stainers (*Dysdercus* spp.).
Cotton plant louse (*Aphis gossypii*, Glover.).
Scale insects.
Cut worms.
Grasshoppers (*Shistocerca pallens*, Thumb.).
Beneficial insects.
Cotton leaf-blister mite (*Eriophyes gossypii*, Banks.).

Notes on Pests attacking Cotton in the West Indies.
By H. A. Ballou, B.Sc.
Vol. IV, Part 4, p. 326. March 12, 1904.
Insects dealt with in this paper are mostly the same as in the previous one. These notes are largely an account of the occurrence of these pests during the preceding cotton season.

Review of the Insect Pests Infesting the Sugar-cane.
By H. A. Ballou, B.Sc.
Vol. VI, Part 6, p. 37. June 3, 1905.
Moth borer (*Diatraea saccharalis*, Fabr.).
Hard back (*Ligyrus tumulosus*, Burm.).
Weevil borer (*Sphenophorus sericeus*, Oliv.).
Root borer (*Diaprepes abbreviatus*, Linn.).
Cane fly (*Delphax saccharivora*, Westwood.).
Scale insects.
Shot borer (*Xyleborus perforans*, Woll.).
The larger moth borer (*Castnia licus*, Drury.).

Insects Attacking Cacao in the West Indies.
By H. A. Ballou, B.Sc.
Vol. VI, Part 1, p. 94. June 3, 1905.
Cacao beetle (*Steirastoma depressum*, Linn.).
Cacao thrips (*Heliothrips* [Physopoda] *rubrocincta*, Giard.).
Other insects.

Insect Pests of Cotton.
By H. A. Ballou, B.Sc.
Vol. VI, Part 2, p. 123. August 26, 1905.
Cotton worm (*Alabama* [Aletia] *argillacea*, Hübner.).
Cotton stainers (*Dysdercus* spp.)
Red maggot (*Porricondyla gossypii*, Coquillett.).
Other insect pests.
Beneficial insects.
A new Cecidomyiid on cotton. Description of *Porricondyla gossypii*, Coquillett.

Anthrax.
By H. A. Ballou, B.Sc.
Vol. VI, Part 2, p. 156. August 26, 1905.
General account of anthrax.
Occurrence in the West Indies.
A paper 'Anthrax in St. Vincent', by Dr. C. W. Branch, was published in connexion with the above.

Notes on West Indian Insects.

Vol. VII, Part 1, p. 40. May 12, 1906.

Notes on the insects of Barbados, St. Vincent, the Grenadines and Grenada. By Mr. Austin H. Clark of Boston, Mass. Reprinted from *Psyche*. Notes on the Butterflies of Barbados. By Sir Gilbert T. Carter, K.C.M.G., Governor of Barbados.
Notes on West Indian Orthoptera. By Mr. James A. G. Rehn. Reprinted from *Entomological News* for June 1905. Notes on a small collection of Orthoptera from the Imperial Department of Agriculture.
Additional Notes on West Indian Insects. By H. A. Ballou, B.Sc.
Notes on Hemiptera, Odonata, Neuroptera, Lepidoptera, Coleoptera, Diptera, Hymenoptera
Bibliography of West Indian Insects

Cotton Stainers.

By H. A. Ballou, B.Sc.

Vol. VII, Part 1, p. 64. May 12, 1906.

The Genus Dysdercus, with a list of American species.
West Indian species. *D. andreae*, Linn. *D. delauneyi*, Leth.
New species *D. fernaldi*, *D. howardi*, *D. howardi*, var. *minor*.
Notes on life-histories.
Food plants.
Damage to cotton.
Damage to crops other than cotton.
Remedies.
Geographical distribution.
Bibliography of cotton stainers.

Insects as Carriers of Disease.

Vol. VII, Part 1, p. 86. May 12, 1906.
From an address delivered at the meeting of the British Association for the Advancement of Science at Pretoria, 1905. By Mr. A. E. Shipley, M.A., F R.S. *Nature*, January 4, 1906.

Leaf-blister Mites.

Vol. VII, Part 4, p. 387. March 23, 1907.
An account of the West Indian species, *Eriophyes gossypii*, Banks; *E. morrisi*, Nalepa; *E. bucidae*, Nalepa; *E. striatus*, Nalepa; and certain species of leaf-blister mites from Fiji, with notes on the preparation and preservation of gall mites.

Thrips on Cacao.

By H. A. Ballou, M.Sc.,

Vol. VIII, Part 2, p. 143. November 28, 1907.
Brief review of thrips with suggestions for treatment and directions for preparing spray mixtures.

Cacao Thrips.

By H. A. Ballou, M.Sc.

Vol. IX, Part 2, p. 190. August 8, 1908.
Similar to preceding.

Treatment of Cotton Pests in the West Indies in 1907.

By H. A. Ballou, M.Sc.

Vol. IX, Part 3, p. 235. November 28, 1908.
Cotton worm (*Alabama* [Aletia] *argillacea*, Hübner.)
The smaller cotton worm (*Aletia luridula*, Guenee.)
The boll worm (*Heliothis* [*armiger*] *obsoleta*, Hübner.)
Aphides and lady-birds.
Cut worms.
Cotton stainers (*Dysdercus* spp.)
Leaf-blister mite (*Eriophyes gossypii*, Banks.)
Red maggot (*Porricondyla gossypii*, Coq.)
Black scale (*Saissetia nigra* [Lecanium nigrum]. Nietn.)
The usefulness of *Zalophothrix mirum*, Crawford, as a parasite of the black scale, is mentioned in this paper.

The Aleyrodidae of Barbados.

By C. C. Gowdey, B.Sc.

Vol. IX, Part 4, p. 345. April 30, 1909.
An account of the West Indian species of this family, with figures and bibliography.

Millions and Mosquitos.

By H. A. Ballou, M.Sc.

Vol. IX, Part 4, p. 382. April 30, 1909.
An account of this useful fish known in Barbados as millions (*Girardinus poeciloides*, de Filippi) and of its habits of destroying mosquito larvae, with accounts of the introduction of millions into several different parts of the world.

Flower-bud Maggot of Cotton. (*Contarinia gossypii*, Felt.)

By H. A. Ballou, M.Sc.

Vol. X, Part 1, p. 1. June 1, 1909.
A new pest of cotton in Antigua identified as *Contarinia gossypii*.
Account of its occurrence in 1908 and in 1909.
Description of the species by Dr. E. P. Felt.
Field and laboratory notes with figures of the insect and of normal and infested flower buds of cotton.

Scarabee of the Sweet Potato. (*Cryptorhynchus batatae*, Waterhouse.)

By H. A. Ballou, M.Sc.

Vol. X, Part 2, p. 180, September 25, 1909.
General account of the scarabee, with figures of thei nsect, and injury to the potato.
An account of laboratory and field experiments.

Original description of the species.
Sweet potato moth (*Protoparce cingulata*, Fabr.) Brief men-
Red spider (*Tetranychus telarius*, Linn.) tion with
Sweet potato weevil (*Cylas formicarius*, Ol.) figures.

Legislation in the West Indies for the Control of Pests and Diseases of Imported Plant.

By H. A. Ballou, M.Sc.

Vol. X, Part 3, p. 197. March 9, 1910.

Gives an account of the older laws dealing with the importation of plants liable to introduce pests and diseases, and of laws more recently passed, providing for the disinfection of imported plants in the islands of the West Indies.

The Disinfection of Imported Plants.

By H. A. Ballou, M.Sc.

Vol. X, Part 4, p. 349. May 28, 1910.

Summary of the laws published in the preceding paper, with directions for the use of insecticides and fungicides. Also general accounts of the nature and use of several of the principal substances used, and a bibliography.

The Nomenclature of Scale Insects.

By H. A. Ballou, M.Sc.

Vol. XI, Part 1, p. 35. September 20, 1910.

A list of the scale insects included in Lefroy's pamphlets, Scale Insects of the Lesser Antilles, with the technical and common names there used, arranged for easy comparison with the technical names given in Fernald's catalogue of the Coccidae.

Notes on Lime Cultivation.

By H. A. Ballou, M.Sc.

Vol. XI, Part 1, p. 39. September 20, 1910.

An account of experiments to show the effect of the methods of cultivation. These indicate that cultural methods influence the abundance of scale insects.

General notes on the cultivation of limes, with mention of the scale insect pests and their natural enemies, and also of the use of Bengal beans are included in the article. A brief summary of the results of the cultivation experiments is also given.

Report on the Prevalence of some Pests and Diseases in the West Indies for the Year 1909-10.

By H. A. Ballou, M.Sc.

Part II, Insect Pests.

Vol. XI, Part 2, p. 85. January 11, 1911

Summary of the insect pests attacking crops in the West Indies 1909-10, prepared from information supplied by Agricultural Officers in the several islands.

Report on a Visit to Florida.
By H. A. Ballou, M.Sc.
Vol. XI, Part 3, p. 172. April 5, 1911.
An account of methods of control in Florida of the scale insects and white fly attacking citrus trees, with special reference to the use of the fungoid parasites of these pests.

PAMPHLETS.

No. 5. General Treatment of Insect Pests. April 4, 1901.
No. 7. Scale Insects of the Lesser Antilles. July 1901.
No. 9. Bee-keeping in the West Indies. August 3, 1901
No. 14. The Screw Worm in St. Lucia. March 22, 1902.
No. 22. Scale Insects of the Lesser Antilles Part II February 23, 1903.
No. 31. A B C of Cotton Planting (Part III, Insect Pests). June 4, 1904.
No. 45. A B C of Cotton Planting (Part III, Insect Pests revised and enlarged). February 11, 1907
No. 55. Millions and Mosquitos. December 9, 1908.
No. 58. Insect Pests of Cacao. March 10, 1909.
Lectures to Sugar Planters.
Lecture VII. Insect Pests of Sugar-cane and Associated Crops. By H Maxwell-Lefroy, M.A., F.E.S., F.Z.S.

A SUMMARY OF TEN YEARS' MYCOLOGICAL WORK OF THE IMPERIAL DEPARTMENT OF AGRICULTURE FOR THE WEST INDIES.

PART I. INTRODUCTION.

The Imperial Department of Agriculture was founded in October 1898, but the original Staff did not include a Mycologist. The need for such an officer, who should also possess a knowledge of general botany was, however, soon recognized, as in November 1900, the Commissioner of Agriculture, Sir Daniel Morris, in a letter to the Colonial Secretary of Barbados wrote as follows: --

'It has been impressed upon me that a capable officer to deal with the various phases of the "Rind" and "Root" diseases in the sugar-cane as well as diseases affecting Indian corn, sweet potatos and other plants, is essential to promote the development of Agricultural efforts in these Colonies.'

Similar letters were also addressed to the Governments of the Windward and Leeward Islands.

The need for such an officer was further emphasized by the fact that fungoid diseases were at that time attacking cacao in Grenada, and that to so serious an extent as to have caused an application from the Government of the Windward Islands to the Imperial Commissioner for duly qualified assistance. The request could not be complied with, as there was no officer so qualified on the Staff of the Department.

It was also becoming necessary to provide for an additional Agricultural Lecturer, as is shown in the succeeding paragraph to that in the letter quoted above: -

'The services of an additional Agricultural Lecturer to give regular courses of lectures to planters and others, to read occasional papers before the Agricultural Society, as well as to give model lessons in Elementary Schools, would also prove of great advantage.'

These services were not to be confined to Barbados, but were to be available for the use of the Governments of the Windward and Leeward Islands also, as was shown in similar letters addressed to those Governments.

It was thought by Sir Daniel Morris that it would be possible to obtain an officer who could combine the two appointments of Mycologist and Agricultural Lecturer, and, in consequence, application was made to the Colonial Office for permission to include such an officer, at any rate provisionally, on the Staff of the Department. Permission was duly accorded for a temporary appointment, commencing in February 1901 and terminating in September 1902. The appointment was, however, renewed on its expiration and has been continued ever since.

The paragraphs from Sir Daniel Morris's letter quoted above indicate the scope of the work to be performed by the officer in question, when the appointment was first under consideration;

the following information, obtained from a memorandum by the same writer under cover of a letter dated April 7, 1905, gives an even clearer definition of the qualifications desired, and the duties to be performed. This is due to the fact that experience had shown more clearly the exact scope of the work to be conducted by the officer referred to. It was understood that he should be a University Graduate in Science Honours, well grounded in General Science, a Botanist, with a special knowledge of fungi; one who had taken a course in Agricultural Science to be preferred. It was also stipulated that he should be prepared to undertake investigations in Mycology, give lectures and addresses when required, visit and report on the work of the Agricultural Schools and assist in editing the publications of the Department.

The officer appointed was to be attached to the Head quarters of the Imperial Department of Agriculture in the West Indies, and to carry out his duties entirely under the direction of the Commissioner. His duties were to comprise travelling when required and the undertaking of such work as might from time to time be entrusted to him. He was to have the use of a good laboratory with access to books of reference and to a fairly well-equipped library containing works relating to Agriculture. He would be required to devote his whole time to the duties of his appointment, and to conform in every particular to the rules of the Department.'

From this outline it is evident that the work of the Mycologist and Agricultural Lecturer falls under three heads: Mycology, Agricultural Teaching, and work connected with the Department's publications. These will be considered independently.

PART II. MYCOLOGY.

EARLY WORK.

Previous to the appointment of a mycologist, and even before the establishment of the Imperial Department of Agriculture, problems relating to fungoid diseases of crops had been dealt with by different agricultural officers in the employment of the Governments of the various islands or groups of islands, as for example, Mr. C. A. Barber and Dr. Watts in the Leeward Islands, Mr. J. R. Bovell in Barbados and Mr. J. H. Hart in Trinidad. These officers confined their investigations principally to the field work connected with the diseases of sugar-cane and cacao, and to the collection of specimens of diseased plants and of the fungi causing the diseases; additional information as to the identity and life-history of each of these fungi was, however, obtained from Massee at the Royal Botanic Gardens, Kew, through the courtesy of the Director. This information was in several instances accompanied by advice and suggestions for dealing with the special disease. Work similar to that conducted by the local officers already referred to was also undertaken by Professor Harrison, Director of Agriculture, and his staff, in British Guiana, and by Mr. W. Fawcett, Director of Public Gardens and Plantations in Jamaica; while work of a more general mycological nature was conducted by Mr. T. D. A. Cockerell, Curator of the Museum in Jamaica.

In connexion with the very serious outbreak of pests and diseases which threatened to destroy the sugar industry in the West Indies during the nineties of the last century, much careful investigation was conducted at the Royal Botanic Gardens, Kew, and recommendations as to its control were provided by the Director. These recommendations were communicated by the Secretary of State for the Colonies, for the information of the Governments of the various islands concerned. In addition, Committees were appointed by the Governments of St. Vincent and Barbados, which were entrusted with the task of recommending measures to overcome the damage caused by these pests and diseases. The report of the St. Vincent committee appeared in 1894. Their recommendations were similar to those made by the Director of the Royal Botanic Gardens, Kew, and were fully endorsed by him (see *Kew Bulletin*, 1894, p. 169). The report of the committee appointed in Barbados was published about a year later (*Kew Bulletin*, 1895, p. 81). At the same time and subsequently, the results of local investigations and recommendations for remedial measures were published in the Annual Reports on Sugar-cane Experiments issued in Barbados and signed by Mr. Bovell, then Superintendent of the Botanic Station, and Professor d'Albuquerque, Island Professor of Chemistry. In the case of cacao, work had been done by Hart in Trinidad and certain specimens had been forwarded to Kew and identified there, so that at any rate a few of the fungi commonly found on this plant were known locally before the work of the Imperial Department commenced.

In addition to the work done locally and at Kew, the diseases of sugar-cane, cacao and citrus plants as well as of some other tropical economic plants had received attention in various other parts of the world, so that there was a very considerable accumulation of mycological knowledge to form a starting point for the work which has since been conducted in the West Indies.

MYCOLOGICAL PUBLICATIONS APPEARING IN THE WEST INDIAN BULLETIN AND IN THE PAMPHLET SERIES.

At the first Agricultural Conference held under the auspices of the Imperial Department of Agriculture, in Barbados, in January 1899, shortly after the foundation of the Department, Mr. Bovell read a paper on The Field Treatment of the Diseases of the Sugar-cane in the West Indies, which contains a summary of what was then known of the pests and diseases of that plant, and shows also the results which had been obtained from experiments with the burning of diseased material, the planting of disease-resistant varieties and the omission of the operation of trashing, as conducted on estates in Barbados. After treating of the moth borer, the author proceeds to describe the fungus, diseases then recognized in the West Indies: these were, the rind fungus, *Trichosphaeria sacchari*, Massee; the root fungus *Colletotrichum falcatum*, Went, and black blight. The first two of these were by far the most important, and were believed by Massee to be merely phases in the life-history of one and the same fungus. After considering the distribution of these fungi in the island, the author proceeds to give accounts of experiments conducted with a view to their control. These consisted of the planting of hardy varieties, including a locally grown seedling, B. 147; the burning of all diseased material, as recommended by the authorities at Kew; and the omission of trashing. Experiments on the disease-resistance and yields of various hardy varieties are also recorded. Finally, full recommendations for dealing with the diseases are given, which include the planting of healthy tops only, their disinfection before planting and the use of rotation of crops, as well as the measures already mentioned. The planting of hardy varieties has since proved by far the most successful course, and may be regarded as having saved the West Indian sugar industry from destruction. The paper referred to was published in the *West Indian Bulletin*, Vol. I, p. 33, issued in July 1899.

In the *West Indian Bulletin*, Vol. I, p. 422, issued in October 1900, appears a paper by Hart entitled Some Fungi of the Cacao Tree. This contains an account of the damage caused to cacao pods by *Phytophthora omnivora*, de Bary, in Trinidad in 1898, and records its occurrence in Surinam and in Grenada. Remedial measures, including spraying with Bordeaux mixture and the burning of all diseased pods and shells, together with a careful search for other host plants of the fungus are recommended. Mention is also made of the presence of *Nectria Bainii*, Massee, on diseased pods, and of another, then unidentified, Nectria on the bark of cacao trees. These were regarded as important owing to the fact that the serious canker disease of cacao bark occurring in Ceylon was also attributed to a species of Nectria. These two papers, then, provide a fair summary of what was known with regard to diseases of sugar-cane and cacao in the West Indies at the end of the year 1900.

In February 1901, Mr. A. Howard, B.A., A.R.C.S., F.C.S., F.L.S., was appointed Acting Mycologist and Agricultural Lecturer on the Staff of the Imperial Department, having previously been seconded to this Department from the local service. He was immediately sent to Grenada, to investigate the diseases of cacao then prevalent in that island; these are referred to above. On his return he submitted a report which was printed in the *Government Gazette* of Grenada and in a fuller form, in the *West Indian Bulletin*. This paper will be dealt with below. Some time had also been spent previously in Barbados, in the investigation of diseases of the sugar-cane; the results of these investigations appeared in two ways; the first was a paper entitled Fungoid Diseases of Sugar-cane, read before the Agricultural Conference held at Barbados in January 1901 and published in the *West Indian Bulletin*, Vol. II, p. 46, issued March 1901. The second was the last of a series of lectures delivered before the Barbados General Argicultural Society on October 15, 1901, and reprinted in book form under the title Lectures to Sugar Planters in 1906.

In the paper in the *West Indian Bulletin* an account is given of the general nature of a fungus and a popular description is provided of the rind fungus, which Howard then believed to be

Trichosphaeria sacchari. The author then deals with the predisposing effect of bad conditions of cultivation and other external factors in assisting the attacks of fungi upon their host plants. After this, there is given a critical consideration of the remedial measures recommended by the Commissioners appointed to consider the question of cane diseases in Barbados, whose report was published in 1895. Finally remedial measures are suggested. Of these the first four had been previously brought forward by various authors, namely the systematic burning of rotten canes, the adoption on every estate of the suggestions made by the Department for dealing with the moth borer, rotation of crops, and the selection of healthy canes for planting. The last three were new and included the adoption of improved methods of cultivation and irrigation, the efficient mechanical cultivation of ratoons and the scientific study of the disease-resisting power of seedlings. It also appears from the subsequent discussion that Howard was not at that time prepared to make any definite statement as to the identity of the rind disease with the root disease. He was not prepared to recommend the burning of the trash, as there was no evidence to show that it contained spores of the rind fungus.

Just previous to the reading of this paper, namely in December 1900, Howard published in the *Annals of Botany*, Vol. XIV, p. 617, a paper entitled On *Trichosphaeria sacchari*, Massee. This gives an account of the scientific study of the fungus, as a result of which the author then believed it to be the cause of rind disease of the sugar-cane, and to possess macro- and micro-conidial stages as stated by Massee (*Annals of Botany*, Vol. VII, p. 128). These conclusions were, however, considerably modified by subsequent work. Even in the lecture on The Fungoid Diseases of the Sugar-cane, referred to above, the author distinguishes between several diseases. The first is the pine-apple disease of cane cuttings due to *Thielaviopsis ethaceticus*, Went. There is no suggestion in this lecture that this fungus has any connexion with the rind fungus. The second is a group of diseases described as root diseases, of which the most important is attributed to a species of Marasmius, while nothing is said as to the precise nature of any of the others. The third is the rind fungus, which is considered as identical with that causing the Red Smut disease of Java. Although no names are mentioned, it is clear that here Howard regards *Colletotrichum falcatum*, Went, as the cause of the disease, and the Melanconium stage of *Trichosphaeria sacchari* as a saprophyte. Another group of diseases mentioned is those attacking the leaf sheath, of which the most important is given as due to *Cercospora vaginae*, Kruger. Various leaf fungi are also referred to in a general manner. Although the lecture is couched in simple terms, yet it marks a new departure as regards giving information concerning the scientific ideas on the subject of cane diseases in the West Indies.

In the same volume of the *West Indian Bulletin*, Part 3, p. 211, issued in October 1901, appears a reproduction of a short preface to the paper by Howard issued in the *Annals of Botany* and referred to above, written by Sir William Thiselton-Dyer. This paper deals with the complicated position with regard to sugar-cane diseases as then known and summarizes Massee's work, discussing the support or criticisms it received at the hands of other authorities. The author gives the reasons for Massee's view, which was also that taken by the authorities at Kew, that rind disease is due to *Trichosphaeria sacchari*—a fungus having three distinct stages in its life-history, of which the macro- and micro-conidial stages were almost certainly identical with the fungus described by Went as *Thielaviopsis ethaceticus*; and that root disease, or at any rate one form of it, was due to a fungus identical in appearance with *Colletotrichum falcatum*, which was also, in reality, only a modified form of *Trichosphaeria sacchari*. The paper by Howard, to which Thiselton-Dyer's was a preface, supported Massee's theory, as has already been stated, to the extent that the Melanconium stage of *Trichosphaeria sacchari* could give rise to a stage in which macro- and micro-conidia were produced.

Another important paper by Howard was issued in the *West Indian Bulletin*, Vol. II, Part 3, p. 190, on The Fungoid Diseases of Cacao in the West Indies. The diseases are dealt with under three heads: pod diseases, stem diseases, and root disease. The pod diseases comprise brown rot, due to *Diplodia cacaoicola*, P. Henn., and occurring in Grenada, St. Lucia, St. Vincent and Dominica, and the two pod diseases found by Hart in Trinidad and referred to above. The first of these was that caused by *Phytophthora omnivora*, the second that attributed to *Nectria Bainii*. The description of the brown pod disease includes the first published account of the life-history of the causative fungus, given in any detail, and also that of the first infection experiments carried out with it. The statement is made that the fungus can attack sugar-cane as well as cacao In the discussion on its systematic position mention is made of the fact that it is probably identical with *Botryodiplodia theobromae*, Pat., which caused a similar disease in Ecuador. The remedial measures suggested include: the picking of all pods before they are too ripe; the burying of all husks and shells with lime; the burying or burning of all old husks on the ground, or of badly diseased pods which may be found on the trees, if these show the presence of the fungus spores; the periodic collection and burning of all dead trees, old prunings and branches. In addition, reduction of shade and spraying with Bordeaux mixture are recommended in dealing with *Phytophthora omnivora*.

The stem diseases are also three in number, namely canker, die-back, and the witches' broom disease. Canker was found in Trinidad, Grenada and Dominica. Two fungi were associated with it in Grenada, namely, *Nectria theobromae*, Massee, and *Calonectria flavida*, Massee, while the latter only occurred in Dominica and was also reported by Hart from Trinidad. Preliminary infection experiments indicated that both these fungi could act as wound parasites. The remedial measures suggested are: treatment of wounds made in pruning and in removing beetle grubs; the removal and burning of all trees killed by the disease and of all dead cacao wood; excision of diseased tissues and tarring of the wounds; and the cutting back of badly diseased trees to allow the growth of a sucker. Die-back disease was found to be due to *Diplodia cacaoicola*, and occurred in

Grenada and St. Vincent. Infection experiments are described, and remedial measures similar to those already mentioned are given. The witches' broom disease is dealt with very shortly as having been found in Surinam and attributed to *Exoascus theobromae*, Ritz. Bos. Howard states that he did not find this fungus on the material examined, but records the presence of a Fusarium.

The root disease was also described, for the first time in any detail. It is reported as occurring in Grenada on cacao, nutmegs and probably mangos, and on cacao in Dominica. The statement is made that it is probably identical with a disease described by C. A. Barber as occurring in Dominica, and recorded on cacao, mango, orange, coffee and bread fruit trees. The remedial measures recommended consist of isolating the diseased trees with a trench and carefully destroying all dead roots before replanting the infected area.

Another supplementary unsigned paper on the witches' broom disease in Surinam appears in the same volume of the *West Indian Bulletin* on page 289. This gives the results of Went's researches, and makes it appear even more doubtful that the disease is due to *Exoascus theobromae.*

These two papers by Howard are all of a directly mycological nature that appeared in Department publications in 1901, but it may be recorded that he published a paper in the *Annals of Botany,* Vol. XV, pp. 683-701 in December 1901, On *Diplodia cacaoicola.* This contains an account of the life-history of the fungus and of the infection experiments which he had carried out.

At the Agricultural Conference held in Barbados in January 1902, Howard read an important paper on The Field Treatment of Cane Cuttings in Reference to Fungoid Diseases. This was subsequently published in the *West Indian Bulletin,* Vol. III, p. 73, issued in May 1902. The author showed that the failure to germinate so often exhibited by cane cuttings was due to a fungus, *Thielaviopsis ethaceticus,* which he stated had been proved to be a stage in the life-history of *Trichosphaeria sacchari.* The presence of this fungus accounted for the usual loss of 30 per cent. of the canes planted, and explained how the practice of planting tops or cuttings from second or third crop canes had originated. It was found to be particularly destructive in a dry season. Although this parasite had been known for some time in Java, its presence in the West Indies had been overlooked, in spite of the fact that its distribution was practically general throughout the islands and British Guiana. The paper contains an account of careful experiments, which proved that the disease could be entirely overcome by treating the cuttings with tar on their exposed ends, and subsequently immersing them for twelve hours in Bordeaux mixture, the total cost with, labour being $12·00 per 100 acres. This treatment was also shown to be valuable when preparing cuttings for transport from one part of a colony to another, or from one colony to another. The experiments further showed that this was preferable to any other method of treatment.

One other paper by Howard was published in the same volume of the *West Indian Bulletin,* p. 189, issued in August

1902, and entitled Suggestions for the Removal of Epiphytes from Cacao and Lime Trees. After showing that epiphytes of all kinds injure the trees by stopping their breathing and, in the case of cacao, by preventing flowering, the author gives accounts of experiments with 4 and 6 per cent. solutions of copper sulphate and of a rosin compound solution, all used as sprays, in ridding the trees of the smaller epiphytes. He states that the larger plants are best removed by hand. The cost of these spraying operations is estimated, and a statement is made that further experiments should be carried out in order to determine the value of this and the increase in yield to which it would give rise, as well as certain other points. It was believed that this treatment would largely increase the yield of trees grown at high elevations, and make the profitable cultivation of cacao possible at heights above the sea-level considerably greater than had been practicable up to that time.

In September 1902 there appeared No. 17 of the Pamphlet Series entitled The General Treatment of Fungoid Pests, prepared by Howard. After dealing shortly with the life-history of a species of Mucor and considering the difference between parasitic and saprophytic fungi, the author goes on to discuss the former class under four heads, namely as causing root diseases, stem diseases, leaf diseases and fruit and seed diseases. Under each heading general remedial measures are given, while directions for the preparation and use of fungicides are included under separate headings. The pamphlet concludes with a consideration of the methods by which new pests are introduced and with directions for collecting and forwarding specimens of diseased plants.

Howard severed his connexion with the Department in September 1902, but he subsequently published three other papers dealing with sugar-cane diseases: one in the *Annals of Botany*, Vol. XVII, p. 373, entitled On Some Diseases of Sugar-cane in the West Indies, and two in the *International Sugar Journal*, Vol. V, that on page 215 being entitled On the Rind Disease of the Sugar-cane in Barbados, and that on page 267, A Root Disease of the Sugar-cane in Barbados.

In these papers the statement is made that as a result of pure cultures and infection experiments which were conducted at Cambridge, rind disease must be regarded as due to *Colletotrichum falcatum*, while *Melanconium sacchari* is only a saprophyte and has no connexion with *Thielaviopsis ethaceticus*, as was beleived to be the case by Massee; further, the common form of root disease is attributed to *Marasmius sacchari*, Wakker, and the disease does not appear to have any connexion with the rind disease. Remedial measures for both are also given.

On September 29, 1902, Mr. L. Lewton-Brain, B.A., was appointed Mycologist and Agricultural Lecturer, on the recommendation of the Director of the Royal Botanic Gardens, Kew. The first paper written by this author for the *West Indian Bulletin* was entitled Disease-resisting Varieties of Plants, and appeared in Vol. IV, p. 48, issued in April 1903. After a discussion of the difficulties to be overcome and the indication of the methods employed in raising hardy varieties of plants, a short summary is given of the work that had then been done with the grape vine, wheat, cotton, coffee, potato, cowpea, sugar-cane and the violet. The paper is of an educational nature, and does not embody any original work beyond its compilation.

About this time, the first steps were being taken by Sir Daniel Morris to revive the cultivation of Sea Island cotton in the West Indies, and in this connexion a paper entitled Fungoid Diseases of Cotton was compiled by Lewton-Brain, and published in the *West Indian Bulletin*, Vol. IV, p. 255, issued in December 1903. This contains a summary of the principal diseases known to attack cotton in various parts of the world, particularly the United States. It has no special reference to the West Indies. The diseases mentioned are: root gall, due to a nematode, *Heterodera radicicola*, Nal.; root rot, provisionally attributed by Atkinson to a species of Ozonium; wilt or frenching, due to *Neocosmospora vasinfecta*, E. Smith; sore shin or damping off, due to a species of Pythium; yellow-leaf blight or mosaic disease, primarily due to unsuitable soil conditions; red leaf blight, a perfectly normal phenomenon; angular spot, due probably to a bacterium; leaf blight, caused by *Sphaerella gossypina*, Atk.; areolate mildew, due to *Ramularia areola*, Atk.; cotton rust, caused by *Uredo gossypii*, Lager; shedding of bolls due to various incompatible external conditions, cotton boll rot, due to *Bacillus gossypinus*; and anthracnose, caused by *Colletotrichum gossypii*, Southworth. The symptoms of all these diseases are described, and remedial measures given.

The last number of this volume of the *West Indian Bulletin*, issued in March 1904, was devoted entirely to information on the subject of cotton cultivation and contains, on page 344, a second paper by Lewton-Brain dealing with the diseases of that crop then known to occur in the West Indies. They comprise: angular leaf spot (*Pseudomonas malvacearum*, Erw. Smith), leaf blight (*Sphaerella gossypina*), cotton rust (*Uredo gossypii*); blotches on the boll attributed to *Sphaerella gossypina*; boll rot (*Bacillus gossypinus*) and anthracnose (*Colletotrichum gossypii*), which last is dealt with at some length.

Volume V of the *West Indian Bulletin* contains only one original paper on mycological subjects, in the shape of a description by Lewton-Brain of the West Indian anthracnose of cotton. This appears in Part 2, p. 178, issued in September 1904. It contains a full account of the symptoms of the disease, and of cultural and inoculation experiments with the causative fungus. The results of correspondence with Mr. W. A. Orton of the United States Department of Agriculture are also given. In discussing the identity of the West Indian fungus, Lewton-Brain comes to the conclusion that it is a variety of *Colletotrichum gossypii*, for which he suggests the name *C. gossypii*, var. *barbadense*. Among the remedial measures it is suggested that diseased bolls should be collected and burned, and that old cotton plants should be burned as early as possible; that cotton should not be planted on the same field in two consecutive years; that healthy seed only should be planted, and that planting should take place so that the ripening of the bolls may occur in dry weather.

Two other short unsigned papers connected with plant diseases also appear in this volume of the bulletin. One, on page 99, entitled Treating Plant Tops and Cuttings with Germicides before Planting, is taken from Part I of the *Report on the Sugar-cane Experiments in the Leeward Islands*, 1902-3. It contains evidence to prove that immersion in Bordeaux mixture alone is efficacious in protecting cane tops and cuttings from disease, especially in a dry season, and that treating the cut ends with tar in addition is not advisable. This was the outcome of a paper by Howard referred to above. The other on page 134 is entitled A Bacterial Rot of Onions. After the quotation of letters showing the distribution of this disease among the islands, a suggestion by Mr. T. Greiner, author of *New Onion Culture* is given, that it may be the same as the bacterial rot investigated at the New York State Experiment Station, Geneva. The paper concludes with extracts from Bulletin No. 164 of this station, which deals with the subject.

Two pamphlets containing information on mycological subjects were issued by the Imperial Department of Agriculture in 1904. The first was No. 29 of the Pamphlet Series entitled Lectures on the Diseases of the Sugar-cane, by L. Lewton-Brain. It embodied the substance of three lectures delivered before the Barbados General Agricultural Society. The first lecture deals with the anatomy and nutrition of the sugar-cane and the formation of cane sugar, from a simple point of view. It also contains an account of the structure, nutrition and reproduction of a fungus. In the second lecture the rind disease attributed to *Trichosphaeria sacchari* and the pine-apple disease (*Thielaviopsis ethaceticus*) are dealt with. Remedial measures similar to those recommended by Howard are given for the first. In connexion with the second, the results of experiments with the treatment recommended by Howard are recorded. In Barbados, tarring the ends and immersion in Bordeaux mixture gave no definite results, as the season was favourable for growth. In Antigua, immersion for two hours in Bordeaux mixture alone was found to be of service, as is recorded above. The last lecture deals with root disease (*Marasmius sacchari*). Remedial measures previously recommended are criticised and finally three are considered efficient—the employment of healthy cuttings, abstention from ratooning on diseased fields, and the destruction of infected material.

The second pamphlet is No. 31 of the series, entitled The A B C of Cotton Planting, in which Part 4, on Blights of Cotton, deals with the chief diseases due to fungi or bacteria. This was also written by Lewton-Brain. It contains a short account of three leaf diseases, none of which were regarded as of a serious nature, namely: rust (*Uredo gossypii*), mildew, caused by an unidentified fungus, and angular spot. Two boll diseases are also mentioned: anthracnose (*Colletotrichum gossypii*) which was only found to be harmful in wet weather; and boll rot or black boll, of bacterial origin, which caused damage in Montserrat in 1903, when the cotton plants were also badly attacked by insects. Remedial measures as given above are suggested in connexion with anthracnose. Disinfection of seed by immersion in corrosive sublimate solution, 1 part in 1,000 of water, for one hour, is also advised.

At the Agricultural Conference held in Trinidad in January 1905, Lewton-Brain read a paper entitled Review of the Principal Fungoid Diseases of the Sugar-cane, which was published in the *West Indian Bulletin*, Vol. VI, p. 33, issued in June 1905. This discusses the three diseases referred to in Pamphlet No. 29 of the Department Series, and comes to the same conclusions as regards the remedial measures to be employed against them. Attention is called to the success which had attended the growing of White Transparent and various seedling varieties of sugar-cane as a remedy for rind disease.

Under the heading Field Treatment of Cane Tops for Planting Purposes, on page 48 of the same number of the bulletin, some information furnished by Mr. J. R. Bovell and Dr. Watts is given, dealing with the disinfection of canes as tested in Barbados and Antigua. The experiments dealt with are the same as those recorded in the *West Indian Bulletin*, Vol. V, p. 96, and in No. 29 of the Pamphlet Series.

Another paper, entitled Fungoid Diseases of Cacao was read by Lewton-Brain at the Trinidad Conference and subsequently published on page 85 of the *West Indian Bulletin*, Vol. VI. This deals with canker (*Nectria* sp.) and die-back (*Diplodia cacaoicola* on the stems, and brown rot *D. cacaoicola* and the disease caused by *Phytophthora omnivora* on the pods. The only new information on these diseases is the record of the occurrence of die-back in Dominica and St. Lucia, and of the Phytophthora disease in St. Lucia and British Guiana. A totally new disease is described under the name of thread blight. It occurred in St. Lucia and also, according to a foot-note, in British Guiana and Trinidad. Two forms, or possibly two distinct diseases, were observed—thread blight and horse-hair blight. Remedial measures recommended were severe pruning and treatment with a lime-sulphur wash. In the discussion following the paper Mr. Hudson recorded the occurrence of the fungus on pois doux (*Inga vera*), bois de basse (*Calyptranthes sericea*), an unidentified forest liane, and bois creole. An addendum contains a short account of the witches' broom disease in Surinam by Dr. van Hall. This writer states that the pod disease and twig disease are due to a fungus with a knotted mycelium, but does not identify it.

On page 117, issued in August 1905, is a paper by Lewton-Brain entitled Fungoid Diseases of Cotton. It deals with the diseases mentioned above, namely rust, leaf spot (*Sphaerella gossypina*), leaf mildew, anthracnose and black boll, in a short manner, and adds a stem disease found on Seabrook Sea Island cotton, associated with a species of Fusarium. In an addendum, a more detailed account of black boll is given, and its occurrence is recorded in Antigua as well as Montserrat.

The last two parts of this volume contain two other papers on mycological subjects. The first, on page 297, entitled Cacao Disease in Ceylon, is a reproduction from the *Tropical Agriculturist* for August 1905, of a paper on Cacao Canker by Mr. Herbert Wright, Controller of Experiment Stations in Ceylon. The second, on page 307, on Bud-rot Disease of the Cocoa-nut Palm, is a summary of some of the literature on the subject of this disease up to the end of 1905. Itsdistribution is given as Jamacia, British Honduras, Cuba, Trinidad and British Guiana.

Mr. Lewton-Brain left this Department in July 1905 to take up a position in Hawaii, and was succeeded in August 1905 by Mr. F. A. Stockdale, B.A.

The first mycological paper produced by Mr. Stockdale in the publications under consideration was presumably contained in No. 45 of the Pamphlet Series published in February 1907. This is an enlarged edition of the A B C of Cotton Planting in which, as in the earlier edition, Part 4 is devoted to the question of blights.

The diseases treated comprise, as above, rust (*Uredo gossypii,*) mildew, and angular spot (*Bacterium malvacearum*) on the leaves; while in this edition round spot (*Sphaerella gossypina*) has been added to the list. Directions are given for the application of lime-sulphur mixture and for the making of Bordeaux mixture. None of the diseases is considered to be of a very serious nature. The diseases of the bolls mentioned are the same as in the earlier edition, namely boll rot and anthracnose (*Colletotrichum gossypii*). The remedial measures recommended for these are the same; and, as before, directions are given for the disinfection of cotton seed. Diseases that do not appear in the earlier edition are an unidentified stem and root disease of seedlings, and a root disease, also unidentified, of older plants. None of these last is considered to be of a serious nature.

An interesting paper by this author, entitled Fungus Diseases of Pine-apples was published in the *West Indian Bulletin*, Vol. VIII, p. 158, issued in November 1907. This was originally intended to be read before the Agricultural Conference of January 1907, held in Jamaica. The proceedings of this Conference were, however, entirely interrupted by the earthquake.

The paper is of a general nature and deals with three diseases of living pine-apple plants and two fungi affecting the fruit when cut for shipping. The diseases are: tangle root, blight, black heart or core rot, and two soft rots of packed fruit. Tangle root was reported from the Botanic Station, Dominica, in 1906. The author states that it is generally attributed to bad preparation of the land before planting. The removal of some of the lower leaves is advised in early stages of the disease; while pulling up, trimming, and replanting in well cultivated soil are recommended in more advanced stages. Blight, whose symptoms are somewhat similar to those of tangle root, is attributed to an unidentified soil fungus which makes its entrance into the roots through the root hairs, of which it causes an abnormal number to develop, on infected plants. Eventually all the roots are killed and the plant dies. In connexion with remedial measures, reference is made to the work done in Queensland by Tyron (*Queensland Agricultural Journal*, Vol. 15, p. 470), and by Webber on specimens submitted to him from Jamaica (*Jamaica Bulletin*, 1901, p. 83). The remedial measures suggested include: the periodical introduction of fresh plants into the cultivation; careful attention to the choice of soil, its cultivation and drainage; and the destruction of all diseased plants and of healthy plants in their neighbourhood, followed by liming of the soil, fallowing, and replanting with healthy suckers. In the case of valuable plants, it is suggested that the lower portions of the stems might be cut off until only healthy roots remain, and that these, after the stripping of the lower leaves, might be replanted. Black heart or core rot occurs in Antigua; the theory of its origin favoured by the author is that it is caused by a species of Penicillium, which gains an entry to the eyes through wounds caused by insects such as mealy-bugs or mites. Parallel experience with a similar disease of pine-apples in Queensland is quoted. The remedial measures recommended are: the destruction of plants showing signs of the disease; supplying with suckers from plants in which the trouble has not previously appeared; avoidance of cuttings from diseased plants, for planting; and the possible use of a disinfectant such as Bordeaux mixture upon cuttings or suckers before planting. It is further suggested that spraying with an insecticide, followed by Bordeaux mixture, may be found necessary.

Two soft rots of packed fruit are mentioned. The first is attributed to *Trichosphaeria sacchari*, which is supposed to enter chiefly through bruises; the second to a species of *Diplodia* entering through the stalk. This information is quoted from the results of unpublished investigations conducted by Howard in 1901. It may be worthy of note that what were actually found were undoubtedly the macro- and micro-conidial fructifications of *Thielaviopsis ethaceticus*, and that Howard at the time considered them to be stages in the life-history of *Trichosphaeria sacchari*. Hence this disease must be considered as identical in origin with that described by Cobb from Hawaii and referred to in the addendum to the paper by Stockdale now under consideration. Species of Penicillium and Aspergillus are also recorded on fruits attacked by the two fungi mentioned above, and on those packed when too green. Among the remedial measures for the disease due to *Trichosphaeria sacchari* are mentioned: avoidance of packing damaged fruit, and packing in well ventilated cases with all possible precautions for minimizing shaking. To prevent the Diplodia disease it is advised that pine-apples be shipped with stalks 4 or 5 inches long; while, when the fruits are especially valuable, the ends of their stalks might be dipped into hot melted wax or tallow.

In March 1908, No. 53 of the Pamphlet Series was issued, under the title A B C of Lime Cultivation. In this, under the heading Pests and Diseases, mention is made of two bracket fungi, *Fomes lucidus*, Fr., and *Polystictus hirsutus*, Fr., occurring especially on old lime trees, but it is thought that the latter only is parasitic. Attention is called to the careful treatment of wounds in connexion with these fungi. Grey or brown spots due to a species of Alternaria are also recorded on lime leaves. The fungus does not, however, appear to do much harm. Damping off of the seedlings in Dominica is reported as taking place during wet weather, or when the seed-beds have been sown too thickly. The disease may be checked by spraying with a 5-per cent. solution of copper sulphate. The presence of 'mistletoe', and of various epiphytes such as ferns, orchids, mosses and lichens is also noted on lime trees growing in wet districts. These are best removed by hand, though it is possible that spraying with a 5-per cent. solution of copper sulphate might prove of use in destroying the smaller epiphytes.

In the *West Indian Bulletin*, Vol. IX, Part 2, p. 103, issued in August 1908, there appears a paper by Stockdale on Root Disease of the Sugar-Cane. This was read before the Agricultural Conference held in Barbados in January 1908. After reviewing the fungi found on the roots of the sugar-cane in various parts of the world, the author confirms the opinions of Howard and Lewton-Brain that the disease in the West Indies is principally due to *Marasmius sacchari*, but adds that it seems probable that various other fungi are also concerned. An account of the distribution of the disease and of its symptoms follows, and remedial measures are recommended. The latter are discussed under the heads of cultural improvements, sanitary measures and the employed of disease resistant varieties. Two points in this connexion are worthy of special note. The first is that a mycelium similar to that of the root disease of sugar-cane is recorded on sweet potatos which are therefore probably unsuitable as a rotation crop The second is the use of lime in large quantities as a fungicide. An advance on the position as regards this disease compared with that set forward by Lewton-Brain is the inclusion of a list of four varieties of seedling canes observed to be comparatively immune from attack. The writer lays strong emphasis on the importance of the disease—a point also emphasized by Dr. Watts in the discussion which followed the presentation of the paper.

At the same Agricultural Conference, Stockdale read a paper entitled Fungus Diseases of Cacao and Sanitation of Cacao Orchards, which was published on page 166 of the number of the *West Indian Bulletin* referred to above. The diseases are considered under three heads, as in Howard's paper, namely, root disease, stem diseases, and pod diseases. A short review is given of the root diseases known in different parts of the world, and it is indicated that the disease in question, found in Grenada, Dominica and St. Lucia, is probably the same as that described by Howard. No definite conclusion as to its identity with those occurring in other parts of the world is arrived at, as no fructifications of the causative fungus had been procured. It is suggested that the fungus spreads to cacao from the roots of infected shade trees, including pois doux, bread fruit, bread nut, mango pomme rose and avocado pear. This fact was definitely established in the case of pois doux and bread fruit. Remedial measures recommended include the destruction of diseased shade trees, the isolation of infected areas by means of a trench, the destruction by burning of badly diseased cacao trees and of infected portions of those less badly attacked, together with forking and liming of the infected soil.

Six stem diseases are considered, two of which are new namely Lasiodiplodia and pink disease. The first to be considered is canker, which is attributed to *Nectria theobromae*, and *Calonectria flavida*, as was done by Howard. The only additions to former information consist in the finding of *N. theobromae* in Dominica, and of both the canker fungi in St. Lucia ; the suggestion that the 'flowering' disease in Dominica may be due to the same fungi ; the recommendation that spraying with a fungicide might prove useful as a remedial measure ; and the advice that a mixture of resin oil and manjak might form an adequate substitute for tar in the treatment of wounds.

The second disease is die-back, due to *Diplodia cacaoicola.* The general description of the disease is the same as that given by Howard, but it is shown that, in addition to the remedial measures recommended by previous writers, careful attention to thorough cultivation, mulching and manuring, are of the greatest importance in treating the disease.

Third on the list is mentioned a disease of stems due to a fungus identified by the United States Department of Agriculture as a species of Lasiodiplodia. It occurred in Grenada and Dominica, while mention is made of a species of the same genus, found by Barrett on cacao in Trinidad. The same or a similar fungus also occurred on roots of cacao in Trinidad, and the same species as is found on the stem developed on scabby pods from Dominica and Grenada. In identifying the fungus, the authorities in the United States remarked that it was identical with a species attacking cacao and mangos in Brazil and San Domingo, which had also been investigated at Washington. The fungus proved to be a weak wound parasite and was often found on old cankered areas. The remedial measures tentatively recommended are similar to those employed against die-back and canker. Further investigation by the present Mycologist to this Department and by various authorities such as Petch and Bancroft in other parts of the world has shown that *Lasiodiplodia* is in reality identical with *Diplodia cacaoicola*—a conclusion which is indicated by a comparison of the description of the latter fungus as afforded by Howard with that of the fungus considered above and given by Stockdale.

The fourth disease is recorded as one due to *Corticium lilaco-fuscum* (= *C. lilacino-fuscum*, Berk. and Curt.) occurring in Dominica and St. Lucia, where it causes what is known as pink disease. This also is reported for the first time, but does not appear to be of much importance ; it may be controlled by the use of lime-sulphur wash.

Thread blights constitute the fifth disease referred to. These were dealt with in a paper by Lewton-Brain. Stockdale reports their occurrence in Dominica and Tobago, in addition to St. Lucia and Trinidad, and adds that comparison of different specimens would indicate that the mycelia belong to different fungi, though no fructifications were found. Horse-hair blight, also described by Lewton-Brain in this connexion, is recorded as having been identified at Kew as *Marasmius equicrinis*, Müll. Remedial measures recommended are the same as those given by Lewton-Brain.

The last stem disease mentioned is the witches' broom disease. The only additions to the information contained in former papers are a record of the success of heavy pruning, and spraying with Bordeaux mixture as control measures, and of the enforcement of the various Plant Protection Acts in order to prevent its introduction into any of the West Indian Islands.

Four pod diseases are considered, comprising brown rot (*Diplodia cacaoicola*), black rot (*Phytophthora omnivora*), scabby pod (*Lasiodiplodia* sp.) and that due to *Nectria Bainii*. Of these the scabby pod disease alone is new; it is reported from Grenada and Dominica, but does not appear to have been of great importance. The fungus mentioned in connexion with it was found to develop on the pods when they were kept in a damp chamber, but no definite proof is given that it is the cause of the disease. The information on the other diseases is the same as that contained in previous papers.

Stockdale's paper concludes with a short discussion of the general principles of sanitation in cacao orchards, involving several points of primary importance.

A simplification of this paper was issued as a pamphlet under the same title in July 1908, and formed No. 54 of the Series.

In the *West Indian Bulletin*, Vol. IX, Part 4, p. 361, issued in April 1909, appears a paper by Stockdale, entitled Fungus Diseases of Cocoa-nuts in the West Indies. It is a summary of a report submitted to the Government of Trinidad as the result of a visit to that island during July and August 1906, for the purpose of investigating these diseases. The full report was published in the *Official Gazette* and was reprinted in pamphlet form by the Agricultural Society of Trinidad. Three diseases were recognized, namely, root disease, leaf disease and bud rot.

The symptoms of root disease are described at some length, and it is attributed to a fungus whose fructifications were found on the petioles of the leaves, though a mycelium of a similar nature to that in the leaves was found in the roots. The fungus was identified by Patouillard as being probably a species of Botryodiplodia, or, if the hyaline spores which it produced represented the final stage in their development, as a Cystosyora, or better, a *Fusicoccum*. Subsequently it was definitely shown to be actually a Botryodiplodia. The remedial measures fall under six heads: destruction of all diseased material; isolation of diseased areas; resting infected land before planting supplies; spraying and application of chemicals; improved cultivation and drainage; and searching for and propagating disease-resistant varieties.

The leaf disease appeared in the form of spots attributed to the agency of *Pestalozzia palmarum*, Cke., while on dead tissues a second fungus, in all probability *Diplodia epicocos*, Cke., was found to occur. The remedial measures to be employed against the former of these fungi consist of the destruction of all dead trees, the removal and destruction of dead and diseased leaves, the spraying of the infected trees with Bordeaux mixture, and careful attention to such points as drainage, manuring and cultivation.

The bud rot disease can be distinguished from the root disease by the fact that the damage generally commences in the centre of the 'cabbage', while the red discoloration of the base of the stem is absent and the roots are healthy. The author is not prepared to make any definite statement as to the cause of the disease, but is inclined to favour the view that it is of bacterial origin. By way of remedial measures, it is suggested that the tops of diseased trees should be cut off and buried deeply with lime, and that the remainder of the trees should be burned; emphasis is laid on the need of co-operation in carrying out this measure. It is also suggested that attempts should be made to obtain a variety of the cocoa-nut palm which is immune to this disease.

Mr. Stockdale left the Imperial Department of Agriculture on February 2, 1909, to take up an appointment in British Guiana and was succeeded on April 12 1909, by Mr. F.W. South, B.A. (Cantab.), the present Mycologist.

Three mycological papers are contained in Vol. X of the *West Indian Bulletin.* The first is that published in Part 3, p. 235, issued in March 1910; this was written by Mr. C. K. Bancroft, B.A. (Cantab.), and is entitled Fungi Causing Diseases of Cultivated Plants in the West Indies. It presents a general summary of most of the fungi known to be parasitic on cultivated plants of all kinds. The fungi are arranged in the order of their classification, and under each is given a short account of the symptoms of the disease due to it, a diagnosis of the fungus where possible, and references to the principal papers dealing with the subject. Two indexes are given, the first arranged under the headings of host plants, the second under those of the parasites. The present Mycologist to this Department also added an appendix on diseases ascribed to bacterial or physiological causes.

The two other papers deal with the root disease of sugar-cane in Antigua and in Barbados. They appear on pages 343 and 347 of Part 4, issued in May 1910; the first written by Mr. H. A. Tempany, B.Sc., Superintendent of Agriculture for the Leeward Islands, embodies the answers to a series of questions as to the extent of the disease, the effect of various cultural methods, and the possible susceptibility of various rotation crops. These questions had been addressed to the planting community of the island and the replies elicited are summarized at the end of the paper. The second contains the answers given by the Superintendent of Agriculture, Barbados, to questions, on the susceptibility to the disease of various rotation crops, drawn up by the Mycologist of the Imperial Department of Agriculture.

The first mycological paper published in the *West Indian Bulletin* by the present Officer appears on page 1 of Vol. XI, issued in September 1910, and is entitled The Control of Scale Insects in the West Indies by Means of Fungoid Parasites. Four fungi are recorded on coccids in the islands, namely, the red-headed fungus (*Sphaerostilbe coccophila,* Tul.), the white-headed fungus (*Ophionectria coccicola,* E. and E.), the black fungus (*Myriangium Duriaei,* Mont. and Berk.), and the shield scale fungus (*Cephalosporium lecanii,* Zimm). A list is given of the scale insects attacked by each, and a table showing detailed records of their occurrence, presenting both the name of the insect attacked and that of the host plant on which it occurred. Methods of introducing the fungi on to healthy scale insects are discussed, together with the use of a cover crop, such as the Bengal bean (*Stizolobium aterrimum*) in creating an atmosphere favourable to their development.

On page 34 of the same number there appears a short illustrated paper by Bancroft, on a New West Indian Cacao Pod Disease. This gives an account of the occurrence on cacao pods from Jamaica, of a new species of Colletotrichum, described and figured in the paper and named by the author *C. Cradwickii.*

In Part 2 of the same volume of the Bulletin, page 73, appears A Report on the Prevalence of Some Pests and Diseases in the West Indies for the year 1909-10; the paper was issued in January 1911. The first portion, relating to fungoid disease, was the work of the present Mycologist to this Department. It contains a short summary, under the headings of the different crops, of the prevalence of their principal diseases in each of the islands in which they occur, as noted in the year under review. Two indexes are given: one, with the crops as its principal headings, shows the diseases peculiar to each and their distribution among the islands; the other, with the names of the islands as principal headings, shows the more important crops occurring in each, with the diseases found on them. This paper, together with the summary by Bancroft referred to above, serves to indicate the position or Mycology in the West Indies at the end of March 1910, as regards those islands coming under the immediate administration of the Imperial Department of Agriculture.

A short paper also by the present officer, was published in Part 3 of the same volume of the Bulletin (page 157) issued in April 1911. It is entitled Fungus Diseases of Ground Nuts in the West Indies and deals with three diseases; the first two, a rust due to *Uredo arachis*, Lag., and a leaf spot caused by *Cercospora personata*, E. and E., are of minor importance; while the third, an unidentified root fungus, is capable of inflicting considerable damage. The last is also important on account of the numerous host plants which it has been found to attack.

This concludes the information with regard to mycological subjects that has appeared in the various volumes of the *West Indian Bulletin* and of the Pamphlet Series, up to the middle of the year 1911. Further information has also been given in the *Agricultural News*; this may now be considered shortly.

MYCOLOGICAL INFORMATION IN THE AGRICULTURAL NEWS.

From the date of its first issue, the *Agricultural News* has contained information of all kinds on mycological subjects. This took the form both of editorial and of general articles appearing irregularly from time to time throughout all the volumes up to Vol. VIII, No. 190, p. 251. In this number a special page was instituted under the heading Fungus Notes, which was entirely devoted to information dealing with plant diseases. A page of this description has appeared in every subsequent number, with the exception of No. 197 in Vol. VIII. Editorial articles having relation to plant diseases have also appeared from time to time in the recent numbers.

The editorials have been devoted principally to the consideration of certain aspects of mycology from a broad and philosophical point of view, though in one or two cases they have dealt with special diseases, as for example that in Vol. IV, p. 369, treating of Bud-rot Disease of the Cocoa-nut Palm. The general articles and those comprised in the Fungus Notes have had three principal objects. Many have been of an educational nature, as for example, the series on pp, 251, 267, and 283 of Volume VIII, which deal with points of interest in the life-history of the fungi, and those concerned with the outlines of classification, and entitled The Chief Groups of Fungi, which commenced on page 78 of Volume IX, and were continued in the seven succeeding numbers. Others again have dealt with specific diseases and have been, in many cases, abstracted from reports submitted to the Imperial Commissioner by the different officers, embodying the results of visits paid to the various islands for purposes of investigating diseases. By far the largest number, however, are abstracts of accounts of current work in plant diseases appearing in publications from other parts of the world, and indicate the application of such work to West Indian conditions. The results obtained by the foreign workers are carefully considered, and it is pointed out how these results confirm or negative work done by this Department. Frequently these articles summarize the position with regard to the diseases of any given host plant as it was known at the time they were written, or deal with several diseases that are common to one or more than one host. Among the examples are summaries of the diseases of rubber-producing plants, of modern work on cocoa-nut and banana diseases, and of the diseases common to cacao and Hevea trees. In addition to the editorial and general articles, short reviews have appeared from time to time of new books or reports on mycological subjects, forwarded from all parts of the world.

These articles, both editorial and general, have been in most instances the work of the Mycologist actually on the Staff of the Department at the time they were written. During the absence of this officer, on duty in other islands or on leave, articles have also been prepared by the editor.

GENERAL WORK.

The general routine work in mycology consists principally of the examination of specimens of diseases forwarded by the local officers of the Department throughout the islands and collected either by themselves or by private individuals. When such examinations have been completed, a short memorandum on the subject is submitted to the Imperial Commissioner and utilized by him in the preparation of answers to the letters accompanying the specimens, while copies of the memoranda themselves are usually attached to such answers. This work occupies a considerable portion of the time, as miscellaneous specimens of all kinds arrive by almost every mail.

In addition to this work, research on the more important diseases is usually in progress, in which the Mycologist is assisted by the local officers in the assembling of data regarding various points such as local distribution and field symptoms, and in the provision of material necessary for the investigation. The collection and identification of various specimens of fungi also form part of the work of the Mycologist. In making the identifications much assistance has been obtained from Mr. G. Massee, at the Royal Botanic Gardens, Kew, whose services have been rendered available through the courtesy of the Director. An exchange of specimens and information has also been maintained with different agricultural institutions in all parts of the world.

TRAVELLING.

From time to time, visits are paid to the various islands by the Mycologist for the purpose of rendering him familiar with the conditions under which agricultural industries are carried on, and of investigating, on the spot, diseases which threaten to become serious; or they are made when there is need of obtaining detailed information regarding the prevalence of diseases in general. On such occasions the officer is usually absent for a week or more, and makes excursions to such estates as afford the best opportunities for the purpose of the visit. A list of the visits paid by the different officers, with their dates, the time occupied in each and their respective objects will be found at the end of this paper. It may be noted that in all 333 days have been spent by the various officers in travelling through the different islands.

WORK REQUIRING ATTENTION.

Although, as will be seen from the above account, much work in mycology has been carried out by this Department, yet there are many points of great interest that still require further investigation. These occur in connexion with almost every crop that is grown. For example, it is very desirable that the fungus causing root disease of cacao and several other useful plants, probably including limes, should be identified, and a definite conclusion reached as to whether there is more than one such disease of common occurrence Inoculation experiments with *Lasiodiplodia theobromae* on many different hosts also require to be carried out to determine its exact range and degree of parasitism. Experiments which have only just been commenced, on spraying cacao with fungicides require to be carried to a definite conclusion. All the diseases of the sugar-cane are in need of further investigation and revision, and careful experiments to discover an economical method of dealing with the root disease of this crop would be of great benefit to the planting community. A serious root fungus found on many host plants including lime seedlings, ground nuts, and several ornamental plants deserves attention, and a thorough investigation of the root disease of Indian corn is much needed. Information is required as to the number and distribution of the diseases of bananas and cocoa-nuts throughout the various islands, while rubber plantations require to be carefully watched. The bacterial boll disease of cotton also demands further attention, and it may be mentioned that a disease of arrowroot and a seedling disease of Hevea plants in Dominica are at present under investigation.

Besides all these, there is a long list of minor diseases, of varying importance economically, but all of interest to a mycologist. It includes, among others, diseases of mangos, thread blights on various hosts, and rusts on Indian corn, imphee, Guinea corn, cotton, ground nuts, and various other plants, the life-cycle of many of the latter diseases being incompletely known. These are only a few of such points, but they serve to illustrate the amount of work that requires to be done and the great variation of its scope.

The above summary of the mycological work conducted by the Imperial Department of Agriculture indicates that much progress has been made during the last ten years. This progress has undoubtedly been attended by a corresponding increase of knowledge of the subject on the part of the planting community at large. Few readers are likely to recognize without some consideration how great this increase has been ; but probably there is not one who would not be prepared to admit it on reflection, and to admit also that the advance in knowledge has not been confined to the subject of mycology only but is noticeable to a parallel extent in all branches of agricultural science.

PART III.

GENERAL BOTANICAL AND EDUCATIONAL WORK.

Under the title of general botanical work, certain papers appearing in the *West Indian Bulletin* and principally confined to the question of producing seedling varieties of the sugar-cane, may now be discussed. The first paper to be considered was contributed by Howard while Lecturer in Agriculture under the local Government of Barbados. It was published in the abovementioned journal, Vol. I, Part 1, p. 396, issued in October 1900, under the title The Fixation of Atmospheric Nitrogen by Leguminous Plants. This is a summary of a translated article which appeared in the *Experiment Station Record*, Vol. V, pp. 749-74 and 835-54 the original of which was written by Professor H. Hellriegel. It contains a clear account of the verification of the important discovery that the nodules on the roots of leguminous plants are inhabited by bacteria possessed of the power of fixing free atmospheric nitrogen, and that by their means plants of this family are enabled to increase considerably the available nitrogen in the soil. In addition to the description of the methods employed in proving this point, there is also given a short description of the experiment station founded by the Association of Sugar-beet Growers at Bernberg in Germany, where Hellriegel's work was conducted.

SELECTION AND HYBRIDIZATION OF THE SUGAR-CANE.

The next paper requiring consideration is one entitled Hybridization of the Sugar-cane, by Lewton-Brain, published in the *West Indian Bulletin*, Vol. IV, Part 1, p. 63, issued in April 1903. The author commences by discussing the structure of a typical flower, and by indicating in what ways the sugar-cane flower differs from this. He then proceeds to consider the raising of new improved varieties of cultivated plants, and points out that this improvement is desired along two lines: one in the direction of an increased yield of the product for which the plant is cultivated, the other in that of increased resistance to disease on the part of the plant itself. After this statement of the objects to be aimed at, it is pointed out that improved varieties of plants may be obtained either by a process of selection or by hybridization. Thereafter follows a summary of recent work in Europe and America on the production of new varieties by selection, and this leads to a consideration of the results obtained in Java and in the West Indies in the attempt to improve the sugar-cane by the selection of new seedling varieties. The author next proceeds to a discussion of the use of hybridization in producing improved varieties of plants. He presents a short outline of some of the work on cereals conducted in England, and then proceeds to give a description of the process employed in artificial cross-pollination.

He points out that crossing is resorted to for two reasons: in the first place, because the offspring of a cross is extremely variable, and consequently provides good material for the process of selection; in the second place, because it may result in combining in the offspring the good characters of the two parents. In regard to the sugar-cane, two groups of methods of effecting hybridization are applicable. The first contains only the natural method, which consists of planting alternate rows of two varieties of cane known to arrow at the same time, and in trusting to chance that cross-pollination will take place. It is pointed out that some of the seedling canes in the West Indies must have originated in a way similar to this, but that the method is unsatisfactory, as it is impossible to tell what proportion of cross-fertilization has taken place. The second group contains the artificial methods of ensuring cross-pollination; three such are discussed: the first recommended by Professor d'Albuquerque, the third by the late Dr. Kobus. The first consists of bagging arrows before they are ripe, and shaking the contents of the bags of one variety into the bags covering the arrows of another. This is open to the objection that more self- than cross-fertilization might well occur, and it would be difficult to tell which seedlings were the result of either process. The second is the method for definitely ensuring cross-pollination described by the author earlier in the paper. This would be very laborious as applied to the sugar-cane. The third depends on the discovery by Dr. Wakker in Java that some varieties of cane do not produce fertile pollen, though the female organs are normal; while the pollen produced by other varieties is fertile. In consequence of this, Kobus planted alternate rows of two varieties, one with fertile pollen and one without; as a result thousands of hybrid sugar-canes were obtained. Following on these experiments, the author undertook the examination of the flowers of a large number of West Indian seedlings and other canes. He found that, while all of them possessed both stamens and pistil, the anthers of certain varieties contained a large proportion of pollen incapable of germination, and, as a result, he was enabled to classify the varieties into three classes. Class I included varieties in which the anthers showed a large proportion of normal pollen; these consisted of seedling varieties only. Class II contained those in which the anthers showed a very small proportion of normal pollen; Class III, those in which there was a moderate proportion of normal pollen in each anther. The last two classes included both standard and seedling varieties. The author points out that, where it is desired to reduce the risk of self-pollination to a minimum, varieties of Class II only should be used as seed-bearing parents, while the use of those of Class I as pollen-producing parents would obviously ensure the best results. He also indicates that hybrids of known parentage can be obtained by planting alternate rows of two varieties, one belonging to Class I and the other to Class II, provided that these varieties are sufficiently isolated to prevent there being much risk of pollen from a third variety reaching the stigmas of the seed-bearing canes. Further, in the light of these investigations, Professor d'Albuquerque's method can be acted upon without the existence of any great risk of self-fertilization. It would seem that the author is of the opinion that the two simpler methods of producing seedling canes may be expected to give satisfactory results.

The next paper on the subject of improved varieties of the sugar-cane was written by Stockdale and published in the *West Indian Bulletin*, Vol. VI, p. 394, issued in February 1906. As was done in the paper just considered, the author outlines the objects of the work; he then gives a careful description of the systems employed in British Guiana and Barbados, respectively, for the selection of seedling sugar-canes. After this he proceeds to a discussion of the question of hybridization, and describes the methods of producing hybrids which were mentioned in Lewton-Brain's paper referred to above. Of these the author of the paper under consideration lays particular emphasis on the purely artificial one, namely, that in which use is made of emasculation and artificial conveyance of the pollen to the stigma. He proceeds to reproduce Lewton-Brain's careful description of the actual technique of the method, as given in the *West Indian Bulletin*. Vol. V, pp. 362-3; and then describes in detail that employed by himself during the arrowing season of 1905, which was a modification of the former method. The paper concludes with a short summary indicating the extent of the success which had attended the introduction of improved seedling varieties of sugar-canes into the various islands of the West Indies.

The next paper on this subject appeared in the *West Indian Bulletin*, Vol. VII, p. 345, issued in March 1907. It was a reproduction of a paper by Morris and Stockdale presented to the International Conference on Genetics held in London in August 1906, under the auspices of the Royal Horticultural Society, and bears the title The Improvement of the Sugar-Cane by Selection and Hybridization. The authors point out that four methods have been utilized for procuring improved varieties of sugar-canes, namely: selection among native varieties; introduction of foreign varieties; hybridization among native varieties; and hybridization between native and introduced varieties. They then discuss the results that have been obtained by the action of selection upon three forms of variation: that in habit and vigour of growth, bud variation, and variation in the sugar content of individual canes, this last forming the basis for chemical selection. After shortly noticing the question of the introduction of foreign varieties for field crops, they take up that of hybridization. An historical sketch of the work is given and an account of the methods employed. Future work is outlined and emphasis is laid on the useful results that may be expected to arise from work conducted along Mendelian lines. This work would naturally necessitate the use of the artificial method of cross-fertilization under control. Then follows a summary of the results obtained with seedling canes in many parts of the world. Sections are next devoted to the actual production in Barbados by the method of fertilization under control of hybrid and self-fertilized seedlings; descriptions of these seedlings follow and, in the case of the hybrids, of both parents. The paper closes with a short statement of general conclusions, in which emphasis is again placed upon the advisability of conducting the work of the future along the definite lines indicated by Mendel's laws, since such work may be expected to provide an analysis of the characters of the principal varieties of canes and thus lead to the synthesis of the ideal cane.

The last paper on the improvement of the sugar-cane was published in the *West Indian Bulletin*, Vol. VIII, p. 79, issued in November 1907. It was written by Stockdale, under the title Breeding Hybrid Sugar-cane, and was intended to be read before the Agricultural Conference held in Jamaica in 1907. It is devoted to a consideration of the results that may be expected to arise by the use of the method of artificial cross-fertilization under control when conducted along Mendelian lines, and of actual experiments started with this object. The earlier methods are not considered.

After shortly recalling the emphasis laid by Morris and Stockdale on the importance of analysing the different characters of different varieties, in the hope that it might be possible to pick out the desirable qualities of one variety and combine them with those of another, the author proceeds to discuss such results as had been obtained from experiments on producing hybrids of known parentage. He then passes on to a description of some of the actual work conducted by Mendel to determine the inheritance, not only of one pair of opposite characters, but also of two such pairs. After this, an account is given of experiments actually in progress in Barbados to determine the inheritance of three pairs of characters: high and low tonnage of cane per acre; richness of juice and the reverse; and resistance and susceptibility to disease. Three separate sets of experiments were started to test each pair of characters independently. In each six carefully chosen varieties were planted. Four of these had the desirable character, two the undesirable. In each, crosses were made between varieties of which one possessed the desirable character and one did not, between varieties of which each possessed the desirable character, and again between those of which each possessed the undesirable character. In this way it was hoped that light would be thrown on the inheritance of each pair of characters. Other crosses were arranged with a view to combining both high tonnage and rich juice in the same seedling. It is further pointed out that some of the parent canes being seedlings themselves might be expected to be hybrids and that, in consequence, some of them were to be self-fertilized in order to test their purity for any given character, and if necessary attempts would be made to obtain from them a strain pure for the desired character. Other experiments for producing hybrid canes by planting alternate rows of 'male' and 'female' canes are also described. In conclusion, the author points out the necessity for obtaining a thorough analytical knowledge of different varieties and indicates that such work must occupy some time. He states, however, that it may reasonably be expected that systematic synthesis of an ideal cane should follow such analysis, and that synthesized canes should prove of considerable economic importance.

EDUCATIONAL WORK AND AGRICULTURAL LECTURES.

In connexion with their training in Natural Science and Agriculture, the Mycological Officers of the Department have been required to devote a certain portion of their time to educational work, and to lecturing in agricultural science. The first duties of this description were undertaken by Howard, who delivered courses of lectures to elementary school teachers in the Windward Islands, and conducted examinations to test their effect. Details of these lectures will be found elsewhere in this number in the article on the subject of Education. It may be mentioned in passing, that the last of this series in Grenada was delivered by Lewton-Brain. Another side of the educational work was that appertaining to the Agricultural Schools in St. Vincent, St. Lucia, and Dominica ; the curriculum for each of these was drawn up by Howard and revised by Stockdale. This work also included occasional visits of inspection, and the conduct of half-yearly examinations. Further details will also be found in the article referred to above. At the request of the General Agricultural and Commercial Society of Barbados, a series of lectures to sugar planters was delivered during the year 1901 by various officers connected with the Department ; the last of these, entitled The Fungoid Diseases of the Sugar-Cane and other West Indian Crops was given by Howard on October 15, 1901. The whole series was published in 1906, in one volume of a booklet, under the title of Lectures to Sugar Planters. A second course of three lectures on The Diseases of the Sugar-Cane was delivered before the same body by Lewton-Brain ; these were commenced on November 17, 1903, and continued at approximately fortnightly intervals. They were published as No. 29 of the Pamphlet Series. This concludes the account of the educational work connected with the Department which has fallen to the share of the mycological officers. It will be seen that much of it was confined to the earlier years, and, being of a pioneer nature has since become unnecessary, or, where necessary, has been continued through other agencies. The recent revision of the course of education undertaken at the Agricultural Schools will also considerably diminish the extent of this work.

PART IV. WORK CONNECTED WITH THE DEPARTMENT PUBLICATIONS.

As will have been gathered from the preceding pages, it has been the duty of the various officers to prepare papers, principally upon subjects which have formed a part of local investigations, for publication in the *West Indian Bulletin*. Papers have also been prepared for reading at the various Agricultural Conferences, which have been published subsequently in the same journal. Other articles, taken from current publications or embodying points of local interest met with during the course of routine work, have been contributed to the majority of the issues of the *Agricultural News*. In addition to this, both Lewton-Brain and Stockdale were required at intervals to assist in the direct editorial work of the Department's publications. This occurred principally at such times as the Scientific Assistant was absent on leave or through ill health; or in the intervals between the resignation of one such officer and the arrival of the next.

Such, then, have been the duties undertaken by the Mycologist and Agricultural Lecturer on the Staff of the Imperial Department of Agriculture. The development and extension of the work of the Department, together with the increased permanency of its system, have brought about changes in the duties that have fallen to his share; but the same factors, to which must be added the growing interest in plant diseases evinced by the community at large, have increased greatly the routine work of examining specimens; while the results of investigations in other parts of the world have made imperative the re-examination and reconsideration of many of the older problems, and have introduced many new ones of primary importance. Thus, though much has been done in the past, both in the West Indies and throughout the tropical world in general, in elucidating the different points connected with the diseases of plants, it represents but a very small fraction of the work which still remains to be done—work which is intimately bound up with the general prosperity, not only of the agricultural community of the West Indies, but with that of all tropical countries; while to the reader is left the consideration of the import of this work to the welfare of the British Empire.

LIST OF OFFICERS WHO HAVE HELD THE APPOINTMENT OF MYCOLOGIST AND AGRICULTURAL LECTURER ON THE STAFF OF THE IMPERIAL DEPARTMENT OF AGRICULTURE.

A. Howard, B.A., A.R.C.S., F.C.S., F.L.S. Formerly Scholar of St. John's College, Cambridge. 1st Class Honours in the Natural Sciences Tripos, Part I, and 2nd Class in Part II Subsequently Lecturer in Agricultural Science, Barbados. Appointed to the Imperial Department of Agriculture, February 9, 1901, resigned September 17, 1902. Subsequently Botanist to the South Eastern Agricultural College, Wye. Late Imperial Economic Botanist to the Government of India.

L. Lewton-Brain, B.A., F.L.S. Formerly Foundation Scholar of St. John's College, Cambridge. 1st Class Honours in the Natural Sciences Tripos Parts I and II, 1900. Hutchinson Student for Research in Botany and University Demonstrator in Botany. Appointed September 29 1902. Resigned the appointment July 8 1905. Subsequently Director of the Division of Pathology and Physiology of the Experiment Station of the Hawaiian Sugar Planters' Association. Now Director of Agriculture for the Federated Malay States.

F. A. Stockdale B.A., F.L.S. Formerly Holmes Exhibitioner of Magdalene College Cambridge. 1st Class in the Natural Sciences Tripos, Part I, 1904. Subsequently Science Master at Oundle School Northamptonshire. Appointed August 15 1905. Resigned the appointment February 2. 1909, and accepted that of Assistant Director of Agriculture and Government Botanist British Guiana.

F. W. South B.A. Emmanuel College Cambridge. 2nd Class in the Natural Sciences Tripos Parts I and II, 1908. Subsequently Assistant Master at Epsom College, Surrey. Appointed April 12 1909.

SYNOPSIS OF WEST INDIAN BULLETIN PAPERS AND OF MYCOLOGICAL PAMPHLETS UNDER THE HEADINGS OF THE RESPECTIVE CROPS TO WHICH THEY REFER.

SUGAR-CANE.

The Field Treatment of the Diseases of Sugar-cane in the West Indies. J. R. Bovell. *W.I.B.* Vol. I p. 33, July 1899.

Rind fungus *Trichosphaeria sacchari.*
Root fungus *Colletotrichum falcatum.*
Black blight.
Discussion of remedial measures.

Fungoid Diseases of Sugar-cane. A Howard, *W.I.B.*, Vol. II, p. 46, March 1901.

General nature of a fungus.
Description of the rind fungus, *Trichosphaeria sacchari.*
Discussion of the predisposing effect of bad external conditions on disease.
Criticism of the remedial measures recommended by the Commission appointed in 1895.
Further remedial measures.

The Fungoid Diseases of the Sugar-cane. A Howard. Lectures to Sugar Planters, 1906.

Pine-apple Disease of Cane Cuttings, *Thielaviopsis ethaceticus.*
Root disease, *Marasmius* sp.
Rind disease, considered as identical with the red smut disease of Java.
Disease of the leaf sheath, *Cercospora vaginae.*

Note on the Sugar-cane Disease of the West Indies. Thiselton-Dyer. *W.I.B.*, Vol. II, p. 211, October 1901.

General discussion of position.
Rind disease, *Trichosphaeria sacchari*, of which the macro- and micro-conidial stages are considered as identical with *Thielaviopsis ethaceticus.*

Root disease, *Colletotrichum falcatum*, considered as a modified form of *Trichosphaeria sacchari.*

The Field Treatment of Cane Cuttings in Reference to Fungoid Diseases. A. Howard. *W.I.B.*, Vol. III, p. 73, May 1902.

Failure to germinate in cane cuttings due to ***Thielaviopsis ethaceticus***, here regarded as stage in life-history of ***Trichosphaeria sacchari.***

Experiments showed that treating the cut ends of the cuttings with tar and immersing them for twelve hours in Bordeaux mixture were efficient preventives against disease.

Treating Plant Tops and Cuttings with Germicides before Planting. *W.I.B.*, Vol. V, p. 99, September 1904.

Evidence is brought forward to prove that immersion in Bordeaux mixture alone is sufficient protection against disease.

Lectures on the Diseases of the Sugar-cane. L. Lewton-Brain. Pamphlet Series. No. 29, February 1904.

Anatomy and nutrition of the sugar-cane.
Structure, nutrition and reproduction of a fungus.
Rind disease, *Trichosphaeria sacchari.*
Root disease, *Marasmius sacchari.*
Pine-apple disease of cuttings, ***Thielaviopsis ethaceticus.***
Remedial measures.

Review of the Principal Fungoid Diseases of the Sugar-cane. L. Lewton-Brain. *W.I.B.*, Vol. VI, p. 33, June 1905.

Same diseases as in Pamphlet No. 29.

Field Treatment of Cane-tops for Planting Purposes. *W.I.B.*, Vol. VI, p. 48, June 1905.

Same results as in *W.I.B.*, Vol. V, p. 96.

Root Disease of the Sugar-cane. F. A. Stockdale. *W.I.B.*, Vol. IX, p. 103, August 1908.

Disease due to ***Marasmius sacchari*** and spp.
Possible occurrence on sweet potatos.
Remedial measures.

Root Disease of the Sugar-cane in Antigua. H. A. Tempany. *W.I.B.*, Vol. X, p. 343, May 1910.

Answers to questions contained in a circular on the subject of root disease sent out to the planters of Antigua.

Root Disease of Sugar-cane in Barbados. *W.I.B.*, Vol. X, p. 347, May 1910.

Answers to questions in a memorandum by the Mycologist of the Imperial Department, supplied by the Superintendent of Agriculture, Barbados.

Hybridization of the Sugar-cane. L. Lewton-Brain. *W.I.B.*, Vol. IV, p. 63, April 1903.

Improvement of the Sugar-cane by Selection and Hybridization. F. A. Stockdale. *W.I.B.*, Vol. VI, p. 394, February 1906.

Improvement of the Sugar-cane by Selection and Hybridization. D. Morris and F. A. Stockdale. *W.I.B.*, Vol. VII, p. 345, March 1907,

Breeding Hybrid Sugar-canes. F. A. Stockdale. *W.I.B.*, Vol. VIII, p. 79, November 1907.

CACAO.

Some Fungi of the Cacao Tree. J. H. Hart. *W.I.B.*, Vol. I, p. 422, October 1900.

Pod diseases, due to *Phytophthora omnivora* and *Nectria Bainii.*

Remedial measures.

Fungoid Diseases of Cacao in the West Indies. A. Howard. *W.I.B.*, Vol. II, p. 190, October 1901.

Pod diseases:—

Brown rot, *Diplodia cacaoicola*, probably *Botryodiplodia theobromae.*

Diseases due to *Phytophthora omnivora* and *Nectria Bainii.*

Stem diseases:—

Canker, *Nectria theobromae* and *Calonectria flavida.*

Die-back, *Diplodia cacaoicola.*

Witches' broom, *Exoascus theobromae.*

Root disease.

The Witches' Broom Disease in Surinam. *W.I.B.*, Vol. II, p. 289, February 1902.

Results of Went's work.

Suggestions for the Removal of Epiphytes from Cacao and Lime Trees. A. Howard. *W.I.B.*, Vol. III, p. 189, August 1902.

The use of copper sulphate solution and rosin compound is suggested as the result of experiments.

Fungoid Diseases of Cacao. L. Lewton-Brain. *W.I.B.*, Vol. VI p. 85, June 1905.

Canker, *Nectria* sp.

Die-back, *Diplodia cacaoicola.*

Pod disease, *Phytophthora omnivora.*

Brown rot, *Diplodia cacaoicola.*

Thread blight.

Cacao Disease in Ceylon. *W.I.B.*, Vol. VI, p. 297, November 1905.

Cacao Canker, H. Wright; reproduced from the *Tropical Agriculturist*, August 1905.

Fungus Diseases of Cacao and Sanitation of Cacao Orchards. F. A. Stockdale. *W.I.B.*, Vol. IX, p. 166, August 1908.
Pamphlet Series No. 54, July 1908.

Root disease.

Stem diseases:—

Canker, *Nectria theobromae* and *Calonectria flavida.*

Die-back, *Diplodia cacaoicola.*

Stem disease, *Lasiodiplodia* sp.

Pink disease, *Corticium lilaco-fuscum*
(= *C. lilacino-fuscum*).

(Thread blights and horse-hair blight. The latter dueto *Marasmius equicrinis.*)

A Witch Broom disease, unidentified.

Pod diseases:—
Brown rot, *Diplodia cacaoicola.*
Black rot, *Phytophthora omnivora.*
Scabby pod, *Lasiodiplodia* sp.
Disease due to *Nectria Bainii.*

New West Indian Cacao Pod Disease. C. K. Bancroft. *W.I.B.* Vol. XI, p. 34. September 1910.

Disease due to *Colletotrichum Cradwickii.*

COTTON.

Fungoid Diseases of Cotton. L. Lewton-Brain, *W.I.B.*, Vol. IV, p. 255, December 1903.

Summary of the diseases from all parts of the world.
Root gall, *Heterodora radicicola.*
Root rot, *Ozonium* sp.?
Wilt or Frenching, *Neocosmospora vasinfecta.*
Sore shin or damping off, *Pythium* sp.
Yellow leaf blight or mosaic disease.
Angular spot.
Leaf blight, *Sphaerella gossypina.*
Areolate mildew, *Ramularia areola.*
Cotton rust, *Uredo gossypii.*
Shedding of bolls.
Boll rot, *Bacillus gossypinus.*
Anthracnose, *Colletotrichum gossypii.*

West Indian Diseases of Cotton. L. Lewton-Brain. *W.I.B.*, Vol. IV, p. 344, March 1904.

Angular leaf spot, *Pseudomonas malvacearum.*
Leaf blight, *Sphaerella gossypina.*
Cotton rust, *Uredo gossypii.*
Blotches on the boll, *Sphaerella gossypina*?
Boll rot, *Bacillus gossypinus.*
Anthracnose, *Colletotrichum gossypii.*

West Indian Anthracnose of Cotton. L. Lewton-Brain. *W.I.B.*, Vol. V, p. 178, September 1904.

Careful consideration of the life-history of *Colletotrichum gossypii* in the West Indies and comparison with the American form, resulting in suggestion of the name, *Colletotrichum gossypii*, var. *barbadense.*
Remedial measures.

The A B C of Cotton Planting. Part 4. L. Lewton-Brain, Pamphlet Series, No. 31, June 1904.

Rust, *Uredo gossypii.*
Mildew, unidentified.
Angular spot.
Anthracnose, *Colletotrichum gossypii.*
Boll rot or black boll due to bacteria.
Disinfection of seed.

Fungoid Diseases of Cotton. L. Lewton-Brain. *W.I.B.*, Vol. VI, p. 117, August 1905.

Same diseases as above and a stem disease associated with *Fusarium* sp.
An addendum is given on black boll.

A B C of Cotton Planting. Part 4, enlarged edition.
F. A. Stockdale. Pamphlet Series. No. 45. February 1907.

The following are added to those in the earlier edition :—
Round spot, *Sphaerella gossypina.*
Stem disease of seedlings, unidentified.
Root disease of seedlings, unidentified.
Root disease of mature plants, unidentified.

COCOA-NUTS.

Bud-rot Disease of the Cocoa-nut Palm. *W. I. B.*, Vol. VI, p. 307, February 1906.

Summary of the literature up to the end of the year 1905.

Fungus Diseases of Cocoa-nuts in the West Indies. F. A. Stockdale. *W.I.B.*, Vol. IX, p. 361, April 1909.

Root disease, attributed to *Botryodiplodia* sp.
Leaf disease, *Pestalozzia palmarum.*
Secondary fungus, *Diplodia epicocos.*
Bud-rot disease.

PINE-APPLES.

Fungus Diseases of Pine-apples. F. A. Stockdale. *W.I.B.*, Vol. VIII, p. 158, November 1907.

Tangle root, due to soil conditions.
Blight, unidentified fungus.
Black heart or core rot, *Penicillium* sp. and insects.
Soft rots of packed fruit, *Trichosphaeria sacchari* and *Diplodia* sp.

LIMES.

A B C of Lime Cultivation. Pamphlet Series No. 53, March 1908.
Two fungi on dead lime wood are recorded, *Fomes lucidus* and *Polystictus hirsutus.*
Grey or brown spots on the leaves, *Alternaria* sp.
Damping off of seedlings, unidentified.
Parasitic mistletoes, epiphytes.

ONIONS.

Bacterial Rot of Onions. *W.I.B.*, p. 134, September 1904.
General discussions of the disease and reproduction of parts of Bulletin No. 164, New York State Experiment Station, Geneva.

GROUND NUTS.

Fungus Diseases of Ground Nuts in the West Indies. F. W. South. *W.I B.*, p. 157, April 1911.

Rust. *Uredo arachidis*
Leaf spot, *Cercospora personata*
Root disease, unidentified.

MISCELLANEOUS.

General Treatment of Fungoid Pests. A Howard. Pamphlet Series No. 17, September, 1902.

Disease-resisting Varieties of Plants. L. Lewton-Brain. *W.I.B.*, Vol. IV, p. 48, April 1903.

Discussion of the general methods employed in raising hardy varieties of plants.

Summary of results obtained with certain crops and ornamental plants.

Control of Scale Insects in the West Indies by means of Fungoid Parasites. F. W. South. *W.I.B.*, Vol. XI, p. 1., September 1910.

Red-headed fungus, *Sphaerostilbe coccophila.*
White-headed fungus, *Ophionectria coccicola.*
Black fungus, *Myriangium Duriaei.*
Shield scale fungus, *Cephalosporium lecanii.*

Lists are given of the scales attacked by each, and the use of a cover crop, such as Bengal beans, is discussed.

SUMMARIES.

Fungi Causing Diseases of Cultivated Plants in the West Indies. C. K. Bancroft. *W.I.B.*, Vol. X, p. 2[illegible] March 1910.

A Report on the Prevalence of some Pests and Diseases in the West Indies for the year 1909-10. Part I. F. W. South. *W.I.B.*, Vol. XI, p. 73, January 1911.

VISITS PAID BY THE MYCOLOGISTS TO OTHER ISLANDS.

A. HOWARD:

Place.	Date.	Special Work.
Grenada	Feb. 14 to March 16, 1901	Cacao Diseases.
Dominica	April 15-27, 1901	Report on the Botanic Station and supervision of the curriculum of the Agricultural School.
St. Vincent	May 13-25, 1901	Similar to the above.
Dominica St. Lucia	Aug. 5-31, 1901	Similar to the above.
St. Vincent	Jan. 7-18, 1902	Lectures to Elementary School Teachers.

Total time spent in travelling, 91 days.

L. LEWTON-BRAIN:

Grenada	Aug. 3-15, 1903	Lectures to Elementary School Teachers and examination.
St. Vincent St. Lucia Dominica	Sept. 28-Oct. 10, 1903	Inspection of Agricultural Schools.

St. Vincent	May 9-15,	1904	Inspection of School and general mycology.
St. Vincent	Aug. 23-27,	1904	Inspection of School.
St. Lucia Dominica	Sept. 6-10,	1904	Inspection of Schools.
Trinidad	Jan. 2-14,	1905	Agricultural Conference.
Antigua Montserrat	Feb. 13-March 6,	1905	Black Boll of Cotton.
St. Vincent	May 2-6,	1905	Agricultural School Inspection.
St. Lucia Dominica	May 15-20,	1905	Agricultural Schools Inspection.

Total time occupied in travelling, 80 days.

F. A. STOCKDALE :

St. Lucia Dominica	April 7-May 1,	1906	Agricultural Schools Inspection.
Trinidad	July 10-Aug. 15,	1906	Investigation of bud rot and other diseases of the cocoa-nut.
Jamaica	Jan. 8-21,	1907	Agricultural Conference.
St. Vincent	Feb. 12-19,	1907	Inspection of Agricultural School.
St. Lucia Dominica	Sept. 17-Oct. 8,	1907	Inspection of Schools and Investigation of plant diseases.
St. Lucia Dominica Antigua	March 31-May 5,	1908	Investigation of root diseases of sugar-canes and of cacao diseases

Total time occupied in travelling, 126 days.

F. W. SOUTH :

Montserrat	March 5-17,	1910	Problems connected with lime cultivation and scale insects.
Grenada	Jan. 29-Feb. 9,	1911	Investigation of cacao diseases and of black blight.
St. Vincent	April 18-31	1911	Investigation of cacao diseases and of arrowroot disease.

Total time spent in travelling, as above, 36 days.

THE WORK IN THE BOTANIC AND EXPERIMENT STATIONS FROM YEAR TO YEAR.

In the following account of the work of the Botanic and Experiment Stations, the facts are made to relate alone to such matters as are presented in the annual reports that have been submitted from year to year. The details presented must therefore be of a formal nature, and appertaining chiefly to work that appears to take a large place in the annual routine; they cannot be considered to afford, in any way, a complete account of all the activities that have obtained in the various stations; nor can they begin to indicate adequately the influence of their work with reference to economic progress in the different islands. For this to be done, the subject would have to be approached in a more intimate manner, in reference to the matter available for consultation at the different stations, and the complete presentation of it would take up much more space than can well be afforded at present.

In consulting the matter which follows, therefore, it must be regarded as a résumé of the information that is available in the annual reports of the several botanic and experiment stations since the year 1899—the time when the work commenced to be effective, under the Imperial Department of Agriculture. Facility in reference is ensured by placing the facts under the main headings of the names of the islands to which they have relation, and the matter is further divided under captions indicating the special work with which it deals.

The different reports present a large number of facts relating to additions and repairs to buildings, annual meteorological returns, visitors to the stations, correspondence and distribution of agricultural information and, in some cases, to prize-holdings competitions, agricultural shows and work in connexion with Arbor Day. These facts do not admit of the making of simple summaries, so that it must be sufficient to refer to them in a general way, and to record the matter of their usual inclusion in the reports. The same is true of the details that are given as to economic plants at the stations; and it may be said, in addition, that the introduction and growing of these have formed some of the most important and useful agricultural work in the islands.

GRENADA.

STAFF.

At the time when the Imperial Department of Agriculture took over the administration of the Botanic Station, Grenada (1899-1900), Mr. W. E. Broadway was in charge as Curator; he held this post until 1904-5, when he retired. In 1901, an additional officer was attached to the staff of the station by the appointment of Mr. M. McNeill, the Officer-in-Charge of the Agricultural School, St. Vincent, as Agricultural Instructor. No changes took place until 1903-4, when Mr. McNeill went home on sick leave, and Mr. W. M. Smith acted in his place. Consequent on the retirement of Mr. Broadway, Mr. R. D. Anstead, B.A. (Cantab.) was appointed to the post of Agricultural Superintendent of Grenada, in 1905-6, and Mr. G. F. Branch Agricultural Instructor in Dominica, was selected to fill the similar position in Grenada, during the same period. The next two years saw no change of note, but in 1908-9, Mr. Anstead resigned the post of Superintendent of Agriculture to take up an agricultural appointment in Southern India. In the next year, 1909-10, Mr. G. G. Auchinleck, B.Sc., was appointed as Superintendent of Agriculture and holds the post at the present time.

In 1909-10, a re-organization took place of the Agricultural Department, in accordance with a scheme which is described in Ordinance No. 8 of 1909, Grenada. By virtue of this, there has been established an Agricultural Board consisting, in the words of the Ordinance, 'of the Colonial Secretary, and of seven other members, one of whom shall be such person holding office under the Government in the Colony as shall be appointed by the Governor, and who shall retain his seat on the Board during pleasure, and six persons, who shall be members of the [Agricultural and Commercial] Society, to be appointed by the Governor. Each such member of the Society so appointed shall continue to be a member of the Board for a period of two years from the date of his appointment unless he shall in the meantime cease to be a member of the Society.

'The Commissioner [of Agriculture] shall whenever he is in the Colony be entitled to sit as a member of the Board with precedence next after the presiding member.'

The following appears among the Regulations, in a Schedule to the Ordinance:—

'The local Department of Agriculture shall be affiliated to the Imperial Department of Agriculture for the West Indies, and its work shall be carried out by the Board in consultation with the Commissioner.'

The Board has advisory and administrative control over the local Department, including the Laboratory, the Botanic Gardens and such agricultural experiments as may be established from time to time.

ORNAMENTAL AND USEFUL PLANTS OF STRIKING SPECIES AT THE STATION.

The botanic garden was laid out on its present site soon after 1886, its situation being one of the alternative places suggested for the purpose by Sir Daniel Morris, while on a visit to the island in that year. During the time that it has been in existence, attention has been given continually to the introduction, growing and distribution of useful and ornamental plants. In regard to the latter kind, this was particularly the case in the first few years of the possession of the gardens—a circumstance that may be demonstrated readily by reference to the earlier annual reports which, it may be mentioned, often give especially useful information in regard to such plants. The southern part of the station is situated on a rich alluvial soil, derived from the denudation of the neighbouring hill, and it is here that well-grown examples of useful plants from many parts of the tropics may be found. The Annual Reports contain very complete lists, and other information relating to these plants.

In the grounds of the Botanic Station, there have been included two plots—one forming an orchard of fruit trees and the other containing examples of useful timber trees. In the case of the former, particularly, much trouble has been experienced with scale insects, with their attendant black blight, especially on account of the ease with which re-infection takes place from plants outside the station. These plots have been useful, not only for the purpose of demonstration, but for that of providing planting material for distribution.

ECONOMIC EXPERIMENTS.

EXPERIMENTS WITH STAPLE CROPS.

CACAO. During the whole of the time under report, cacao has been grown in experiment plots attached to the garden. In 1900, when experiment plots were taken over by the Government in several districts, manurial trials with cacao were made in them. Work in these plots ceased in 1904-5. Notwithstanding the trouble with epiphytic plants in those at the greater altitudes, definite general results seem to have been obtained to the effect that, under the conditions, applications of basic slag and sulphate of ammonia gave greater success than those of sheep and pen manure. Returning to the experiment plots at the station, these were divided up in 1905-6, and the experimentation was made more definite. These suffered severely from drought in 1906-7, and had not recovered by the next season, although some good effect was received from mulching with leaves and lawn sweepings, where these were used. The work in the plots at the station was continued subsequently to this, but the station reports do not show that they yielded any definite results. In 1905-6, work on four experiment plots in country districts was commenced, and a new set of experiment stations in country districts inaugurated, at the suggestion of the Imperial Commissioner of Agriculture. These were situated on estates, and consisted of large plots containing at least 1,000 trees, the arrangement of working being that the owners of the estates should bear all expenses, while scientific advice and control were supplied by the Imperial Department, mainly through the Agricultural Instructor, acting under the Agricultural Superintendent. An extension of such experiment stations to additional estates took place in 1906-7. With reference to the experiment plots, the work on these progressed steadily, and an additional plot was added as the result of a recommendation of a Commission appointed by His Excellency the Governor in March 1907, to enquire into certain matters relating to the peasant proprietary of the island. In 1908-9, the manurial investigations were extended in the direction of trials to ascertain if inoculated cowpeas would grow under cacao shade in Grenada. In spite of any assistance that may have been derived from inoculation, the plants did not grow, and the conclusive result of the experiment and of a former trial, without inoculation, was that cowpeas will not flourish under cacao shade, in Grenada. This account of work with cacao at the station and in country districts may be concluded by the statement that the whole system of experiment plots and sations was revised and changed at the time of the re-organization of the Agricultural Department, in 1909-10.

NUTMEGS. These were grown in the experiment plots attached to the station, having been planted in 1900-1. Six years later, in 1905-6, a large number of the trees was cut out on account of the fact that they were found to be ‘ male ’ trees. No subsequent mention of these plots is contained in the reports; they seemed to have been employed mainly for the production of planting material for distribution in the island.

SUGAR. No experiments of the kind described later for Antigua, Barbados and St. Kitts have been carried out in Grenada; the matter is not as important in Grenada as in the latter islands, as most of the sugar-cane is grown for local consumption and for the production of rum. Definite mention of the plots occurs in the reports for 1900, 1901 and 1902-3; like those on which nutmegs are grown, they were used chiefly for the production of planting material to be distributed in the island.

EXPERIMENTS WITH PROVISION CROPS.

The following table has been constructed for the purpose of showing the extent to which the Annual Reports of the Botanic and Experiment Stations deal with experiments with provision crops, in Grenada :—

	1900-1.	1901-2.	1902-3.	1903-4.	1904-5.	1905-6.	1906-7.	1907-8.	1908-9.	1909-10.
Egg plant *(Solanum Melongena)* ...	+		+							
Yams (*Dioscorea sativa*)...			+	+	+	+	+	+		+
Eddoes			+	+		+				
Tanias			+	+						
Sweet Potatos			+	+				+	+	+
Onions			+							
Spinach				+						
Ground nuts (*Arachis hypogaea*) ...					+					+
Cassava (*Manihot* spp.)					+	+				
Artichokes						+	+			
Pigeon pea (*Cajanus indicus*)						+	+			

A commencement of definite experimentation was made in 1902-3 with the formation of an 'Index Plot', suggested by the Imperial Commissioner of Agriculture. In a general way, it may be said that no great success has been obtained with provision crops at the Grenada Botanic Station, on account of the fact that the unsuitability of the soil to such plants precluded the gaining of any results of interest; hence the plots, like those of nutmegs and sugar-cane mentioned above, have found their main employment in the provision of planting material—a specially important matter in this case, in connexion with attempts to bring about a larger diversification of crops in Grenada.

Nothing further requires mention except that the report for 1909-10 gives results for two years' experimentation with yams, and trials for three years with sweet potatos.

EXPERIMENTS WITH VARIOUS CROPS.

The work at the Grenada Botanic Station has been of such a nature that it has included much less experimentation with ordinary crops than has been carried out in most of the other islands; there is not, therefore, a great deal to describe in this connexion. In regard to experiments with corn and millet crops, it is recorded that, in 1903-4, trials with Peruvian maize resulted in an entire failure. In 1905-6, a plot of 12-week corn was first established, from seeds supplied by the Imperial Commissioner of Agriculture; this corn has been grown regularly every year, and the seed meets with a large demand, particularly on the part of the peasantry. There has also been a considerable enquiry for Guinea corn, which is mentioned in the report for 1908-9; according to the report for 1909-10, this crop had been grown to provide seed for distribution since 1905.

The records for green dressing crops show that, in 1900, the Commissioner of Agriculture forwarded to the station, to be used in green manuring experiments, seeds of various leguminous plants. Other leguminous plants mentioned from time to time are: woolly pyrol (*Phaseolus lunatus*) (1904-5), pigeon pea (*Cajanus indicus*) (1905-6and 1906-7), Bengal bean (*Stizolobium aterrimum*), horse bean (*Canavalia ensiformis*), cowpea (*Vigna Catjang*), the soy bean (*Glycine hispida*) and *Crotalaria retusa*. The work with pasture and fodder crops is shown to have included trials with Antigua hay grass (*Andropogon caricosus*) (1903-4), in which the growth was satisfactory; *Trifolium Johnsoni* (1900); alfalfa (*Medicago sativa*) in 1901; while *Pennisetum triflorum* and Barbados sour grass (*Andropogon pertusus*) were grown, mainly for distribution, in 1902-3. Lastly, the oil crops that are reported to have come under trial are sesame (*Sesamum indicum*) in 1904-5, and castor oil (*Ricinus communis*) in 1908-9.

MISCELLANEOUS TRIALS WITH CROPS.

The miscellaneous trials with crops in Grenada have been made with the following: banana, apple and Chinese, 1900 and 1905-6, respectively; coffee, Arabian (1903-4 to 1906-7); coffee. Liberian (1902-3 to 1906-7); cotton (1904-5 to 1908-9); limes (1901 to 1905-6); pine-apples (1902-3 to 1904-5); pyrethrum (1901); rubber (1906-7 to 1909-10); strawberries (1900); vanilla (1905-6).

Although Sea Island cotton and rubber are treated here, for Grenada, under the heading of miscellaneous trials of crops, they are likely to become of much greater importance in the agriculture of the island, in the future. and this is particularly true of rubber. Dealing with Sea Island cotton, this is first mentioned in 1904-5, as the subject of successful trial. The report for 1905-6 states that a small plot of Sea Island cotton had been grown 'each year' with a large amount of success; in this year experiment plots were started in the country, as well as a new one at the Botanic Station. The records for 1906-7 show that only fair success was obtained with the crop at one of the three stations; at the other the trials were spoiled by the advent of excessive rains when the crop was ripening. A check was received to the experiments in the next year (1907-8), because there was no gin in the island available for dealing with the cotton from the experiment plots. and on account of the fact that the seed-cotton could not be sent for ginning to St. Vincent and Barbados, owing to the passing of laws by those Colonies against the importation of seed-cotton and seed. The statement is made, however, that the trials had demonstrated that cotton will yield a satisfactory crop on light. sandy soils, near the coast, in Grenada. The next season, 1908-9, saw greater success with the experiments; they are not mentioned in the report for 1909-10, though there is a statement to the effect that small areas of the Sea Island and Marie Galante varieties were being grown in the Colony.

The report for 1906-7 is the first to give attention to rubber. It states that a large demand had come into being for seeds of Central American rubber (*Castilloa elastica*) and Para rubber plants (*Hevea brasiliensis*); the former was found to grow well, but slowly, in the mountain districts in Grenada, though it was subject to attacks by a mealy-bug (probably *Pseudococcus* [Dactylopius] *citri*), and the black blight accompanying this. At the time (1906-7), the rubber-yielding plants at the station comprised: *Castilloa elastica*, *Hevea brasiliensis*, *Funtumia elastica*, *Ficus elastica*, *F. Vogelii*, *Sapium biglandulosum*, *Manihot Glaziovii*, *Landolphia Kirkii* and *Parameria glandulifera*. Later, Hevea largely replaced Castilloa in the favour of planters, and in the report for this period, Lagos rubber (*Funtumia elastica*) is mentioned as having been planted on one estate; the interesting fact is reported that Hevea plants barely three years old had been observed to have attained a height of 20 feet. It was in this season that a plot each of Hevea, Castilloa and Funtumia was made near the timber plot at the station, so that they may be available for experiments in tapping when the time comes for this to be done on estates. Much disappointment occurred in 1908-9, on account of the partial failure to germinate of a large amount of seed from Ceylon, and this led to the planting of Castilloa by some planters, who preferred to take this course rather than to await the arrival of more seed. During this season, the Funtumia plants began to show signs that they are not satisfactory for growing in Grenada; they are very subject to attacks from scale insects and black light. In relation to the same season, it is reported that seeds had been obtained from Ceara trees (*Manihot Glaziovii*) at the Botanic Station, and on one estate. Lastly, with reference to 1908-9, Jequié and Remanso

Maniçoba rubber (*M. dichotoma* and *M. piauhyensis*) were introduced, with the aid of the Imperial Commissioner of Agriculture. In the last season under review, observation has continued to show that Hevea is better suited to conditions in Grenada than Castilloa, on account of the susceptibility, already mentioned, of the latter to scale insects and black blight. Nevertheless it is recorded that on one estate a small amount of Castilloa was tapped during the season, and that the results promised success.

ST. VINCENT.

STAFF.

At the time of the first report on the Botanic Gardens, St. Vincent, issued by the Commissioner of Agriculture in 1901, they were in charge of Mr. H. Powell as Curator, and this continued to be the case in 1902-3. In the next year, however, Mr. Powell was appointed to the post of Agricultural Instructor at Mombasa, in the East African Protectorate, and was succeeded by Mr. W. N. Sands, Curator of the Botanic Station, Antigua, under the title of Agricultural Superintendent. In the interim before Mr. Sands's appointment, Mr. C. H. Knowles, Master in charge of the Agricultural School, acted as Curator. This officer had been appointed to the Agricultural School in 1901, in the place of Mr. M. McNeill, who had become Agricultural Instructor in Grenada

Mr. Sands holds the post of Agricultural Superintendent at the present time. There have, however, been changes at the Agricultural School, for Mr. Knowles was appointed as Superintendent of Agriculture at Fiji, in 1904-5, and was succeeded by Mr. W. H. Patterson, Curator of the Botanic Station, Antigua, Mr. A. J. Clarke of Barbados, having acted as Resident Master in the interim.

LAND SETTLEMENT SCHEME.

In relation to the Land Settlement Scheme in St. Vincent, the Curator of the Botanic Station was responsible for the work in connexion with visits to the country, etc., but in 1902-3 this was found to take up too much of his time, and Mr. T. Osment was appointed as Agricultural Instructor under the Curator in connexion with the Scheme. The conditions remained the same until 1907-8, when Mr. G. Frazer acted for Mr. Osment, and obtained his post in 1908-9, when that officer was transferred to the Public Works Department. In addition to the giving of advice to peasant proprietors, the Land Settlement Scheme of St. Vincent has included the raising of useful plants in large quantities, for distribution. An account of the scheme will be found in the *West Indian Bulletin*, Vol. XI. p. 194.

STRIKING USEFUL AND ORNAMENTAL PLANTS.

The history of the St. Vincent Botanic Station, as the successor of what was probably the first institution of its kind in the New World, is of much interest. This institution, founded in 1765, is described in the Report on the Botanic Station, St. Vincent, for 1906-7, to which reference is made for further particulars. It is partly due to the circumstance that the present station was established on a portion of the site of the old Garden (in 1890—see *Kew Bulletin*, 1891, p. 141) that the interest of some of the more striking plants is all the greater. Circumstances do not permit of the description of these and other notable plants in permanent growth at the station. It must suffice to say that due and particular regard has always existed toward this side of the usefulness of the station, and that it therefore possesses a collection of permanent plants whose value is maintained by additions whenever it is possible for these to be made.

THE VETERINARY SURGEON.

In 1906-7, Mr. C. P. Stoute, M.D.V., was appointed to the newly instituted post of Veterinary Surgeon of St. Vincent, and in the same year a visit was paid to the island by Professor H.E. Annett, M.D., D. Ph, of the Incorporated Institute of Comparative Pathology, his services having been obtained by the Imperial Commissioner of Agriculture. Professor Annett devised a scheme for stamping out anthrax in St. Vincent, and the details were recorded in the Report for 1906-7. As a consequence of the advice given, a Rule was made under The Cattle Diseases Prevention Act, 1869, by which the ears of dead animals are sent to the nearest police station, at the time of the report of death to be forwarded for examination by the Veterinary Surgeon, who when anthrax is found, gives instructions for the disposal of the carcasses, particulars of which are contained in the report to which reference is made. In 1907-8 anthrax vaccinating officers were appointed; it was not found possible to insist on compulsory vaccination, so the treatment was made free except in the case of owners who can afford to pay, and these are charged certain fees which are reduced in respect of large numbers of animals treated at the same time. It was found that animals were being sold for food while undergoing vaccination, so that a Regulation was made, to prevent this (gazetted September 9, 1909). Help has been given in connexion with the work against anthrax by the resident master at the Agricultural School, and by the late Dr. C.W. Branch, Medical Officer of District No. 1. Reports on the work have been drawn up by the Veterinary Surgeon since 1905-6, and consultation of the tables in these affords interesting information in connexion with anthrax and the measures against the disease, in St. Vincent.

The following table, compiled from the Reports, shows the total deaths among stock in the island, and the deaths from anthrax, from the first period reported upon (August 1906 to March 1907) until 1909-10; it also contains information as to the number of animals that received complete treatment with vaccine during the same periods:—

	1906-7.	1907-8.	1908-9.	1909-10.	Total.
Total deaths reported	593	845	685	829	2,952
Deaths from anthrax	256	470	271	353	1,350
Number of animals vaccinated	...	5,554	3,433	4,879	(13,866)

ECONOMIC EXPERIMENTS.

EXPERIMENTS WITH STAPLE CROPS.

COTTON. Trials of various kinds, with cotton, were made at the Botanic Stations and in country districts; after 1901-2, however, all the experimental work was transferred gradually to the Agricultural School, so that most of what is mentioned below refers more particularly to experiments carried out at that institution; by 1903-4 the only crops raised at the Botanic Station were those of a more permanent nature. It should be mentioned, in passing, that experiments with Sea Island cotton, conducted in the island of Bequia (one of the Grenadines), showed that this variety could be grown in the Grenadines on the lower, flatter lands having a good depth of soil, in the place of the inferior Marie Galante, raised at present. Other work of interest demonstrated that, with good, deep cultivation and manuring, fair crops of cotton of good quality may be grown on the land devastated by the eruptions of the Soufrière in 1902-3; that the employment of such manures as pen manure and crushed cotton seed, for cotton-growing, is advisable; that corrosive sublimate is useful in the disinfection of seed in connexion with the control of anthracnose. Cotton lint selection and seed selection have been carried out continuously. The experiments in country districts were given up in 1907-8, but selection experiments, in nurseries, were continued by several planters for the purpose of maintaining the quality of the product. Further matters of interest are that cotton selection experiments were resumed by the Department in 1909-10, and that useful results have been obtained in relation to the employment of implemental tillage in cotton cultivation. Further information with reference to the latter subject is contained below under the heading Sugar.

ARROWROOT. Trials of varieties of arrowroot were made in 1902-3. In the same year, and in 1903-4, experiments were conducted in country districts which showed that arrowroot would grow well in a mixture of volcanic ash and soil, but not in the ash alone. The crop has continued to be raised at the Agricultural School, but not in connexion with any definite experimentation; attention is drawn to the fact that this plant is frequently attacked, on estates, by the arrowroot worm (*Calpodes ethlius*). In 1909-10, the suggestion was made by the Commissioner of Agriculture that the arrowroot industry in St. Vincent should be assisted by the exploitation of by-products. At this time reference is made to proposals for the formation of an Arrowroot Growers' and Exporters' Association, and the placing of an export tax on arrowroot from St. Vincent to provide money for advertising purposes. It may be stated that both these matters of proposition have since become actual facts. Finally, in regard to arrowroot-growing, the later reports all contain accounts of the state of the industry

SUGAR. The production of sugar, like that of cassava and cacao, to be dealt with below, may be regarded in St. Vincent as a subsidiary staple industry. In regard to the first, the reports show that in 1901 plots were planted by the Agricultural Department with sugar-cane, in country districts. Similarly in the next two seasons, trials were made with sugar-cane grown in volcanic ash and in soil and ash, when it was found that the plants flourished best in the ash from the two chief eruptions, mixed with soil, but not well in ash alone. Subsequently, most of the work with sugar-cane has been concerned with the raising of selected varieties for distribution, and in connexion with this a nursery has been maintained for some time at the Agricultural School, and this has resulted in the planting of several such varieties in the Carib country (which suffered chiefly from the eruptions) by owners, so that an impetus has thus been given to the cane-growing industry in those districts. In some cases, large plots of sugar-cane have been established by owners, for the purpose of ascertaining the varieties that are best suited for cultivation under local conditions. One of the most notable circumstances in connexion with sugar-cane in St. Vincent is that, in 1909-10, important implemental tillage experiments, for this crop as well as for cotton, were started under the direction of the Imperial Department of Agriculture, aided indirectly by several planters in Antigua, who willingly afforded information to the Agricultural Instructor, when he was on a visit to that island for the purpose of gaining requisite knowledge in relation to the matter. For further information concerning implemental tillage in St. Vincent, see Report for 1909-10 and the *Agricultural News*, Vol. IX, pp. 3, 35, and 229; reference may also be made to the *West Indian Bulletin*, Vol. X, pp. 318 and 322.

CASSAVA. As with cotton, arrowroot, and sugar-cane, experiments were carried out, with cassava, especially in 1903-4, to find out if the plant could be grown well in volcanic ash, and it was shown that, as with those crops, success was obtained with the ash mixed with ordinary soil. The general results of this investigation are interesting, and may be found in the Report for the year just mentioned. In 1905-6, Colombian cassavas were imported for propagation and distribution to estates. In the next year, samples of cassava starch were sent to England for the purpose of ascertaining its usefulness for sizing, in connexion with cotton-spinning, but further trials are required before a conclusion can be reached. Little more of interest occurs in the Reports, concerning cassava, except that in 1909-10 an effort was being made on one group of estates to produce cassava starch on a considerable scale, for export to the United Kingdom.

CACAO. As has been stated, the production of cacao in St. Vincent may be regarded as a subsidiary staple industry; the crop does not receive much attention in the Reports. In 1901, cacao plots were planted in several country districts; while in the next year, Alligator cacao (*Theobroma pentagona*) and Red Ocumare cacao plants were raised from seed sent by the Imperial Department of Agriculture; subsequently, these varieties were planted out successfully at the Botanic Station. At this Station, cacao has remained among the permanent crops, chiefly for purposes of demonstration and distribution, while it has also formed an item in the cultivation at the Agricultural School. In 1905-6, a distribution of planting material of the Madura shade tree (*Gliricidia maculata*) was made to planters, for the provision of shade for cacao. The Report for the next year contains an account of the best conditions for cacao-growing, and most of those that have been issued more lately present particulars of the cacao industry in St. Vincent.

EXPERIMENTS WITH PROVISION AND OTHER CROPS.

The trials of which the following are the data, were mostly carried out at the Agricultural School. Here, produce was also raised for food alone, but this does not receive consideration in the following table.

PROVISION CROPS.	1900-1.	1901-2.	1902-3.	1903-4.	1904-5.	1905-6.	1906-7.	1907-8.	1908-9.	1909-10.
Irish potato (*Solanum tuberosum*)		+								
Onions (*Allium Cepa*)		+								
Sweet potato (*Ipomoea Batatas*) ...		+	+							
Ground nut (*Arachis hypogaea*)... ...			+						+	
Tanias			+							
Cabbage			+							
Cowpeas			+							
Beans, edible			+							
Squash			+							
Cassava				+						
Pigeon pea (*Cajanus indicus*)						+	+	+		
Artichoke								+		
Manila bean (*Sophocarpus tetragonobolus*)								+		
CORN AND MILLET CROPS.										
Guinea corn (*Andropogon Sorghum*, var. *vulgaris*)			+			+	+			
Imphee (*Andropogon Sorghum*, var *saccharatus*)						+				
Maize (*Zea Mays*)...							+	+		
GREEN DRESSING CROPS.										
Cowpeas (*Vigna Catjang*)			+							
Pigeon pea (*Cajanus indicus*)					+	+	+			
Soy bean (*Glycine hispida*)					+					
Bokhara clover (*Melilotus alba*) . .					+					
Japan clover (*Lespedeza striata*) ...					+					
Woolly pyrol (*Phaseolus Mungo*) ...						+				

PASTURE AND FODDER CROPS.	1900-1.	1901-2.	1902-3.	1903-4.	1904-5.	1905-6.	1906-7.	1907-8.	1908-9.	1909-10.
Hay grass, Antigua (*Andropon caricosus*)			+	+	+	+	+	+		
Teosinte (*Euchlaena mexicana*) ..			+	+	+		+	+		
Guinea corn (*Andropogon Sorghum*, var. *vulgaris*)			+			+	+	+		
Egyptian clover (*Trifolium alexandrinum*)				+						
Barbados sour grass (*Andropogon pertusus*)				+	+	+	+	+		
Guinea grass (*Panicum maximum*) .				+		+	+	+		
Imphee (*Andropogon Sorghum*, var. *saccharatus* . ..						+	+			
Bokhara clover (*Melilotus alba*) .						+				
Japan clover (*Lespedeza striata*) ..						+				
Maize (*Zea Mays*)							+	+		
Rape (*Brassica Napus*)							+			
OIL CROPS.										
Soy bean (*Glycine hispida*)						+				
Ground nut (*Arachis hypogaea*) ..			+	+			+	+		
Lemon grass, Cochin (*Cymbopogon flexuosus*)							+			

Much difficulty has been experienced in St. Vincent, in regard to experiments with such crops as Irish potatos and onions, on account of the ravages of mole crickets. At the Agricultural School, the crops were grown for purposes of demonstration, or even for supply, rather than in connexion with definite experimentation. In regard to pasture and fodder crops, the work has possessed a special importance in view of the scarcity of food for stock, that continually arises, and it is with reference to this circumstance that demonstrations in hay-making have been held from time to time at the Agricultural School. Lastly, reference has been made to experiments in relation to the growing of plants in volcanic ash and in the ash mixed with soil; the general results of these are to be found in the Report for 1903-4, p. 9.

MISCELLANEOUS CROPS AND SUBJECTS.

In addition to what has been mentioned already, the Reports on the Botanic Stations, etc., St. Vincent, contain references to the following: Agricultural Shows (at the Agricultural School), 1903-4 to 1905-6; bananas, 1902-3 and 1904-5; bee-keeping, 1902-3; cocoa-nut planting, 1901-2 and 1902-3; coffee, 1901-2 to 1904-5; exhibits for Canada, 1903-4 and 1906-7 to 1909-10; fumigation of plants, 1905-6 to 1908-9; Imperial Institute exhibits, 1905-6; insect pests (special observations at the Agricultural School), 1907-8 and 1909-10; lime-growing, 1907-8; nutmegs 1902-3 to 1906-7; Peruvian cotton, 1902-3; pine-apple culture, 1901-2 and 1904-5; plant collection, 1906-7; rubber, Assam, 1902-3 and 1908-9; rubber, Central American, 1906-7 to 1908-9; rubber, Jequié Maniçoba 1908-9; rubber, Lagos, 1902-3 and 1906-7; rubber, Para, 1906-7, 1908-9 and 1909-10; rubber, Remanso Maniçoba, 1908-9; school gardens. 1903-4 to 1906-7; seed-packing experiment, 1905-6; shade trees, 1901-2; tobacco 1907-8. This list does not include places of short mention of a few minor plants and crops.

The account of the St. Vincent Reports would not be adequate without reference to certain other subjects, which will receive attention in the concluding paragraphs. The first of these is the matter of Live Stock. In 1902-3, a few stud and other animals were kept at an estate in the country, and thence, in 1903-4, a Hereford bull, imported by the Imperial Department of Agriculture, was sent to the Agricultural School, where in the same year Belgian hares were obtained, and to which a Toggenburg ram ('Paul') was presented by the Imperial Commissioner of Agriculture. At the same time, Africansheep were also kept at the school, while in 1904-5, poultry was introduced. Stock has continued to be maintained at the St. Vincent Agricultural School, chiefly for the purpose of improving the animals bred in the island. and for instructing the pupils at the school in the methods of feeding and keeping stock. Further particulars are contained in the general report given on page 279 of the present issue of the *West Indian Bulletin*, while details will be found in the various Annual Reports.

As has just been indicated, increasing attention has been given to rubber in St. Vincent. The Report of 1902-3 makes mention of the obtaining of rubber from *Ficus elastica.* In 1906-7, a plot of Castilloa was formed at the Botanic Station, and in the same year Funtumia was found, at the Agricultural School. to be very susceptible to black blight. In 1907-8 and 1908-9, the Castilloa plants at the Station are reported as having been attacked severely by scale insects, and in the Report for the latter period, the conditions at the Station are stated to be unsuitable for Ceara. In 1908-9, again, Jequié and Remanso Maniçoba rubbers were introduced at the Botanic Station, and in the Report for this period it is mentioned that the Assam and Para rubber trees, only, remained free from pests and diseases. The Para rubber trees at the St. Vincent Botanic Station are stated to have flowered, but not to have set seed.

Other matters should receive short mention. Attention has been given to school gardens, mainly in the direction of the distribution of planting material. In regard to the volcanic eruptions, reports and samples of the ejectamenta were sent to various authorities and institutions. In 1905-6, a Permanent Exhibition Committee was formed, with the Agricultural Superintendent as Honorary Secretary. In connexion with this, it should be stated that the collections of exhibits, for such exhibitions as those held in Canada, are made up at the Agricultural School by the Officer in-Charge—the present Honorary Secretary. As a result of the work of the Committee, a show case of exhibits of the produce of the Colony has been placed in the Public Free Library. Lastly, during 1905-6, an Ordinance was passed entitled The Importation of Plant Diseases Prevention Ordinance, and apparatus for the fumigation of plants was erected at the Central Cotton Ginnery.

BARBADOS.

The treatment of botanic and experiment station matters relating to the work that has received report during the period under review will be necessarily different from that for the other islands. The difference will consist chiefly in the circumstance that no résumé will be given of the general botanical and experiment station work, in the way that has been adopted for these. This course is necessitated by the fact that no reports of this work were printed before 1906-7, and if such attention were given to those issued since that time, it would bring about an invidious comparison with the reported work of the other stations, which usually extends over the complete period that is being described. It will suffice to mention that printed reports are available, of the more general agricultural work in Barbados, for the periods 1906-7 to 1909-10.

SUGAR-CANE EXPERIMENTS.

The circumstances are otherwise in regard to the investigations in connexion with sugar-cane, for which a complete series of voluminous reports has been issued by the Commissioner of Agriculture, in addition to those which describe the investigations made before the Imperial Department of Agriculture was constituted. The following forms a short summary of the information contained in the Reports ; in its compilation, use has been made of a review of the sugar-cane work in Barbados, given in the *Report on the Agricultural and Botanical Departments*, Barbados, 1898-1907. The summary may be commenced by giving a quotation from the latter-mentioned source (pp. 8 and 9.) :—

'In 1898, the Imperial Department of Agriculture for the West Indies was established, and since that time * the work of the Botanic Station and of the local Department of Agriculture has been carried out under the Department. A sum of £1,500 for sugar-cane and other agricultural experiments was in 1899-1900, added to the amount already granted by the Government of Barbados and grants have been continued each year since. The staff was increased on the Agricultural side ultimately by two assistants and two clerks, and that on the Chemical side by two assistants. With this increase of staff and resources, the plan of sugar-cane experiments and agricultural research was entirely re-organized. First it was arranged to raise large numbers of seedling varieties at a central experiment station, with records of parentage of these seedlings, to study their characteristics in the field and laboratory, and in the light of that study, while rapidly propagating the more promising varieties (selected varieties) simultaneously to exercise a rigorous weeding-out process with regard to the less promising varieties.

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* Written in 1906-7.—Ed., *W.I.B.*

'An irrigated field was laid out for the purpose of ensuring the growth of the seedlings when first planted out, and for ensuring a "spring" from their stumps in the dry season in the following year, after the canes had been cut down for analysis. The effect of this was to enable the complete cane to be analysed, and yet secure a supply of "seed cane" for the subsequent propagation of the variety. Secondly, Select Variety Stations were established in all the typical parts of the island, and at each of these the select varieties were planted in experimental plots, together with the standard commercial variety and certain other older varieties, the object being to test under actual estate conditions of cultivation, the relative merits in field and laboratory of these seedling varieties, in all parts of the island. Thirdly, those of the select varieties that commended themselves most highly to the planters were next planted on a small estate scale. and facilities were afforded for records of the weighing of the canes, volume of juice, and chemical analysis. As a result of this process of selection and multiplication the best varieties are being ultimately made available for distribution on a commercial scale. Since the establishment of the Department some 29,943 canes * have been reared from seed and are in various stages of the process of testing.

'The manurial experiments which since 1886 had been carried on at Dodds experimental station were there continued. In addition, large fields were laid out in manurial experiment plots in plant canes in typical black soils, and in plant canes and ratoons in typical red soils.'

The experiments on the possibility of increasing the richness of the sugar-cane by the chemical selection of the cuttings from the richest canes were continued on a greatly increased scale. The relative merits of different varieties of Leguminosae and of sweet potatos, and of different methods of tillage also formed the subject of careful investigation. These different developments of the agricultural work as well as that in connexion with cotton are dealt with in separate parts of this report.

The following table has been constructed with the aid of the facts given in the Report just mentioned, pp. 9 to 11, and from the particulars in the large Reports, in the case of the periods 1905-7 to 1908-10. It presents the names of the varieties of canes that have shown the greatest success, during the different seasons, both as plants and ratoons, and on the black and red soils:—

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* Up to 1906-7.—Ed. *W.I.B.*

Season.	BLACK SOILS.		RED SOILS.	
	Plants.	Ratoons.	Plants.	Ratoons.
1898-1900	B. 147	...	B. 147	...
	B. 347	...	B. 156	...
1899-1901	W. Trans.	W. Trans.	Sealy Seedling	W. Trans.
	B. 208	Jamaica cane	B. 208	Jamaica cane.
1900-2	B. 376	B. 208	Sealy Seedling	Sealy Seedling
	B. 208	. .	...	...
1901-3	Sport White	B. 147	B. 208	Jamaica cane
	B. 208	W. Trans.	...	B. 379
1902-4	B. 1,529	D. 95	B. 208	D. 95
	B. 208	B. 208	B. 1,529	...
1903-5	B. 147	D. 95	B. 208	D. 95
	B. 1,529	B. 208	B. 1,529	W. Trans.
1904-6	D. 95	B. 1,529	B. 1,566	B. 1,566
	B. 3,696	B. 376	B. 376	D. 95
1905-7	B. 3,696	W. Trans.	B. 3,405	D. 95
	B. 208	D. 95	B. 3,412	B. 1,566
1906-8	Sealy Seedling	W. Trans.	B. 1,521	B. 1,386
	B. 3,412	B. 208	B. 3,405	B. 376
1907-9	B. 3,013	...	B. 208	...
	B. 6,381	...	B. 3,405	...
1908-10	B. 6,450	...	B. 6,450	...
	B. 6,292	...	B. 3,922	...

The above facts serve to indicate in a broad way the chief results of the work of ascertaining the value of certain varieties of sugar-cane seedlings, that have arisen by natural crossing, under the conditions that obtain in Barbados. Further work having relation to the production of seedlings has been conducted in the direction of obtaining seed by means of cross-pollination by hand (hybridization); the lines on which this has been conducted are described in the *West Indian Bulletin*, Vol. VIII, p. 79. A third way in which new seedlings are obtained is by bagging the arrows of some of the best varieties, before they open, so as to ensure that the seeds formed will be the product of self-fertilization. None of the seedlings obtained by hand fertilization and cross-pollination have proved to be of sufficient value for cultivation on a large scale; the results that have been obtained so far are presented in the *Report of the Agricultural Work for the Season between 1908-10*, Barbados, Part III.

In connexion with the improvement of the sugar-cane, other efforts have been in the direction of bringing this about by the selection of canes rich in sugar, for planting; details of these are contained in the various reports.

The manurial experiments with sugar-cane have been carried out in plots situated on land belonging to the local Government (at Dodds Reformatory), as well as on certain private estates situated on both the black and the red soils of the island—in the latter case with the permission and co-operation of the proprietors and attorneys of the estates. In regard to the latter, co-operative experiments, the results are of too detailed a nature to admit of the presentation of a simple summary. With reference to the former—the work at Dodds—an outline of the general results obtained during the seventeen years of experimentation is contained in Pamphlet 66 of the Department Series, entitled *Seedling Canes and Manurial Experiments at Barbados*, 1908-10, which presents the matter of the larger *Report of the Agricultural Work for the Season between 1908-10*, Barbados, in an abbreviated form. This outline, as presented in the pamphlet, is as follows :—

'For the seventeen years these plots have received regularly farmyard manure at the rate of twenty tons per acre, approximately two squares (800 cubic feet) per acre. In addition, one plot received an extra 20 tons of farmyard manure, equal to 40 tons per acre. In the nitrogen series each plot received 80 pounds of assimilable phosphates as superphosphate of lime and 60 pounds of potash as sulphate of potash. One plot received nothing further, and the remaining plots received varying quantities of nitrogen as sulphate of ammonia, nitrate of soda and dried blood. In the phosphate series, in addition to the 20 tons of farmyard manure, each plot received 60 pounds potash as sulphate of potash. One plot received nothing further. Four plots received varying quantities of phosphate as superphosphate of lime, and two plots received basic slag, one at the rate of 80 pounds, and the other at the rate of 100 pounds per acre. In the potash series, in addition to the 20 tons of farmyard manure, each plot received 80 pounds of assimilable phosphates as superphosphate of lime and 60 pounds of nitrogen as sulphate of ammonia. One plot received nothing further, the remaining plots received varying quantities of potash as sulphate of potash. In the nitrogen series, the best monetary result was obtained where 40 pounds nitrogen, 15 pounds in January and 25 pounds in June was applied in the form of sulphate of ammonia. In this case after deducting the cost of the manure, a gain of $13·91 was obtained over the no-manure plot and $12·91 over the plot that received only phosphates and potash. The next best monetary result was obtained where dried blood containing 60 pounds nitrogen was applied in January : in this case there was a gain of $11·05 over no manure and of $10·05 over no nitrogen : this was also the plot that gave the greatest yield of canes and sugar. Without going into any further figures it will be sufficient to note that nitrate of soda was distinctly inferior to sulphate of ammonia, that 80 pounds of nitrogen as sulphate of ammonia applied in June was so far excessive as to prevent any monetary gain by manuring, in other words, the cost of this manure swallowed up the value of this small increase of yield. With this exception all the nitrogen plots showed a smaller or greater monetary gain over no nitrogen. With regard to the phosphate series, it will be sufficient to say that five out of seven of the plots show a considerable monetary loss compared with the no-phosphate plot, and whether it be due to premature ripening of the cane or to some other cause, it would appear that in land similar to Dodds and under the climatic conditions there existing, the application of phosphates to cane crops is not only useless but prejudicial.

'In the potash series all the plots show an increased yield and monetary gain by the application of sulphate of potash. The plot that gave the largest yield and the largest profit in the series, was the one that received 80 pounds potash applied in January: the gain thereby was 750 pounds saccharose worth $7.

'We may again conclude by pointing out that a comparison of the results of the whole of the experiments shows that, with the exception of the basic slag plots referred to above, those that received no phosphate have for the past seventeen years given the best results, and it would appear that the effect of phosphates on the two fields at Dodds on which the experiments were carried out has been a reduction in the yield. We are therefore of opinion that the time has arrived when those planters, who apply large quantities of phosphates to their fields should consider the desirability of having a few manurial experiments on their estates, say, of half-acre, or acre plots, in one or two level fields, of fairly average composition, where the conditions are as far as possible identical. To one plot they should apply nitrogen and potash, to another nitrogen, potash and superphosphate of lime and to a third nitrogen, potash and basic slag, and continue these applications year after year for some time until they ascertain whether there exists the necessity for the large quantities of phosphates that are at present applied.'

The manurial work with the sugar-cane in Barbados has required, incidentally, investigations connected with the composition of the rainfall, analysis of the soils in which the experimental canes were grown, analysis of manures, as well as other matters in connexion with side issues of the direct experimentation. Among the latter have been tillage experiments conducted in 1901-3 (for summary, see *Report on the Agricultural and Botanical Department*, Barbados, 1898-1907), investigations of the cutting out of 'dead hearts' for the control of the sugar-cane root borer (*Diaprepes abbreviatus*); and in 1908-10 the experiments were made to include trials with calcium cyanamide.

EXPERIMENTS WITH COTTON.

The extent of the work that has been done, in Barbados, with cotton, makes it expedient that a brief review shall be included here. The position of matters up to the end of 1906-7 is indicated in the following extracts from the Annual Report of that period:—

'About June 1902, just about the time that the results of experiments in growing cotton, started by the Imperial Department of Agriculture at St. Lucia and Montserrat, were published, a number of planters in Barbados commenced growing the crop. The area planted in cotton that year was about 16 acres. The result of these experiments proved so satisfactory that the cultivation of cotton was enthusiastically taken up by a number of planters.

'At the beginning of 1903, on the suggestion of the Imperial Commissioner of Agriculture, the Agricultural Society appointed a Committee of their body to co-operate with the Imperial Department of Agriculture in furthering the establishment of the cotton industry.

'At this time Sir Daniel Morris, the Imperial Commissioner of Agriculture, perceiving the great possibility for the West Indies that lay in the cotton industry, paid a visit to the Sea Islands, accompanied by Mr. J. R. Bovell, made a complete study of the methods of cotton cultivation, as well as of seed selection and ginning there practised, arranged for the engagement in the West Indies of a Sea Island cotton expert, and clinched the matter by purchasing about £300 worth of the best Sea Island cotton seed. The wisdom of this purchase was shown, when in a following year the further supply of seed from the Sea Islands was prohibited. This visit and its consequences formed the turning point in the cotton industry, and it has been aptly expressed by a Barbados planter that the Imperial Department gave at the very beginning a start of at least ten years to cotton growers in Barbados. Since that time the Department has maintained and improved the quantity of the seed by its continued work on selection, and has preserved the industry from the extinction threatened by insect pests and fungoid diseases, by the unremitting vigilance exercised through the technical officers of the Department.

'About the same time the Agricultural Society petitioned the Governor-in Executive Committee, asking him to submit and recommend to the Legislature the passing of a Resolution for £250 for the purpose of erecting a small factory for ginning the cotton that had been grown. The Legislature readily voted this sum; but before the factory could be erected, so much progress had been made with the industry that it was seen that a factory of the small dimensions originally suggested would not be capable of ginning, within reasonable time, all the cotton sent to it. Then, at the request of the Imperial Commissioner of Agriculture, the Governor-in-Executive Committee was good enough to loan to the Cotton Committee a building originally erected in the parish of Christ Church at a cost of £283, for the purpose of serving as a smallpox hospital, but which had never been used. The building, which was 100 feet long by 26 feet wide, was, with the assistance of a number of the planters, who lent carts and waggons, moved into Bridgetown and erected on the Pier Head; a boiler and engine were purchased, and a gin and baling press, which had been loaned by the British Cotton-growing Association, were put up.

'From 16 acres of cotton grown in 1902 there were ginned 4,286 ℔. of lint. In December 1903, the Cotton Committee finding that the funds at their disposal were insufficient for the completion of the factory, applied to the Governor-in-Executive Committee for an additional grant of £120 for that purpose, and in the following month the Legislature, on the recommendation of his Excellency the Governor, was good enough to vote that sum.

'At the beginning of 1904, Mr. Seabrook the cotton-ginning expert, who had been engaged by Sir Daniel Morris in connexion with the erection of factories in the West Indies, arrived in

Barbados and rendered valuable assistance in setting the gins and showing the persons in charge of the factory how cotton should be ginned and baled.

'In 1904, the Governor-in-Executive Committee authorized advances to peasants and other small growers, on the seed-cotton sent to the factory, to the extent of £275. The amounts of the loans were deducted from the proceeds of the cotton shipped, and the balance was paid to the growers. In December 1904, a disintegrator, loaned to the Committee by the British Cotton-growing Association was erected for the purpose of crushing cotton seed, thus enabling the seed to be readily used for feeding the estate animals. For the season 1903-4, about 800 acres were planted in cotton, from which the Barbados Cotton Central Factory received seed-cotton which yielded 104,923 lb. of lint.

'In January 1905, a baling press similar to those used in the Sea Islands for baling long-stapled cotton was imported by the Committee, and erected. The old baling press which had been sent out in the first instance by the British Cotton-growing Association was, at the request of the Imperial Commissioner of Agriculture, sent to the island of St. Lucia. In 1905, owing to the rapid advances made in growing the cotton, the Legislature loaned the Cotton Committee £1,200, at the rate of 6 per cent. per annum, for the purpose of making advances to the peasants and other small proprietors on the seed-cotton sent by them to the factory. The first year the cotton was ginned, baled, etc., at the rate of 1½*d.* per lb., the price usually charged in the United States of America. At the end of that year, however, the Cotton Committee found that it was possible to refund to the cotton growers ½*d.* for every pound of lint ginned. The following year they charged 1*d.* per lb., and at the end of the season they were able to return a further ¼*d.* per lb., the charge for ginning and baling being thus reduced to ¾*d.* For the season 1904-5, about 1,647 acres were planted with cotton in Barbados, and from this area the Central Factory received seed-cotton, which yielded 215,500 lb. of lint.

'On November 1, 1905, the factory with its appurtenances was with the approval of the Governor-in-Executive Committee and the Legislature, transferred to the Barbados Co-operative Cotton Factory, Ltd., a company that had been started for the purpose, for £600 first mortgage debenture bonds, at 3 per cent. per annum, the bonds to be redeemed at any time within twenty-one years at the option of the company. The Barbados Co-operative Cotton Factory, Ltd., also agreed to pay to the British Cotton-growing Association the sum of £150 for the gins and disintegrator at the factory belonging to the Association.

MANURIAL EXPERIMENTS.

'In 1905 owing to the rapid increase of the cotton industry, it was deemed desirable to institute a series of manurial experiments for the purpose of ascertaining the requirements of the Sea Island cotton plants under the soil and climatic conditions existing in the different districts of the island. The objects of the experiments were to ascertain (1) the quantity of nitrogen needed to produce the best results when combined with sufficient phosphoric acid and potash to enable that constituent to exercise its full effects: (2) to ascertain in like manner the requirements of the cotton plant with regard to phosphoric acid when combined with sufficient nitrogen and potash, and (3) its requirements as regards potash when combined with the necessary amount of nitrogen and phosphoric acid.

'The experiments for 1905 were conducted on two estates. On one estate unfortunately, however, owing to the attack of the black scale (*Lecanium nigrum* [= *Saissetia nigra*]), the results could not be taken into consideration. On the other, the results were eminently satisfactory. The plots were divided into four series: (1) No manure series, (2) Nitrogen series, (3) Phosphate series, (4) Potash series.

'In the nitrogen series, each plot received 60 ℔. of phosphoric acid as superphosphate of lime, and 20 ℔. of potash as sulphate of potash. One plot in the series received nothing further, but the other three plots received in addition 10, 20, and 30 ℔. of nitrogen respectively.

'In the phosphate series, each plot received 20 ℔. of nitrogen as sulphate of ammonia, and 20 ℔. of potash. One plot received nothing further. The other four plots received 20, 30, 60, and 80 ℔. of phosphoric acid respectively, as superphosphate of lime.

'In the potash series, each plot received 20 ℔. of nitrogen as sulphate of ammonia, and 60 ℔. of phosphoric acid as superphosphate of lime. In the case of one plot this formed all the manure supplied. The other three plots received 10, 20, and 30 ℔. of phosphate respectively, as sulphate of potash.

'In the nitrogen series, there was a proportionate increase in the return as the result of the addition of nitrogen. The best result was obtained where nitrogen as sulphate of ammonia was applied at the rate of 30 ℔. per acre. The increased yield amounted to 279 ℔. of seed-cotton. This was estimated to be of the value of 7c. per ℔., and after deducting the cost of the manure, the profit over the no-nitrogen plot was $9·36, and over the no-manure plot $10·11.

'In the phosphoric acid series, the best results were obtained where 40 ℔. of phosphoric acid as superphosphate of lime were applied. The increase due to manuring was 281 ℔. of seed-cotton, and after deducting the cost of the manure, the profit over the no-phosphate plot was $11·87 per acre. and over the no-manure plot $12·99.

'In the potash series, the most satisfactory returns were given where 20 ℔. of potash as sulphate of potash were applied. The increase in this case, due to manuring, was 196 ℔. of seed-cotton, and after deducting the cost of the manure, the profit by manuring over the no-potash plot was $1·77 per acre, and over the no-manure plot $5·95.'

SEED SELECTION EXPERIMENTS.

'In addition to the manurial experiments, experiments were started in 1905 for the purpose of maintaining, and, if possible, increasing the quality and the quantity of the cotton grown upon the acre. With that object in view, the best plants growing in the field on four estates were selected. The plants thus selected in the field were free from disease, cone-shaped with plenty of lateral branches, short internodes, i.e., plants capable of bearing a large number of bolls. To each plant was attached a numbered label and a piece of red tape, and by the side of the plant was placed a pole which reached above the level of the plants so that it could be seen from a distance and the marked plant easily found. At the same time a number of Osnaburg bags for holding the cotton, and numbered to correspond with the numbers attached to the plants, were obtained. As soon as the cotton from each plant was ripe, it was carefully picked and put in the bag numbered to correspond with the number of the plant, and sent to the office of the Imperial Commissioner of Agriculture. There it was examined by Mr. Thomas Thornton, A.R.C.S., Travelling Inspector in connexion with Cotton Investigations, with the object of ascertaining the length of the staple, the proportion of lint to seed, the proportion of weak fibres, the fineness and silkiness of fibres, etc. The seed from the best plant on each estate was kept separate from the remainder and returned to the estate to be planted in a plot by itself, from whence the best plants were selected the following year.'

As has been indicated, all the above remarks refer to cotton-growing and cotton experimentation in Barbados up to the end of 1906-7. The further general reports, issued so far, have been two—that relating to the periods 1907-8 and 1908-9, and the last dealing with 1909-10; the matter in these will be employed in stating what follows. As regards the industry, the increased incidence of pests and diseases during the last three seasons for which reports are available, together with the lowering of prices, for the lint, that has taken place, has caused a decreasing area to be put in, for each successive period, as follows: 1907-8, 7,194; 1908-9, 5,768 acres; 1909-10, 4,121 acres. In relation to manurial experiments with cotton, there is no reference to these in the Reports for the seasons just mentioned; accounts of work done in Barbados, in this direction, appear in the *West Indian Bulletin*, Vols. VIII, p. 173; IX, p. 195. The work having for its object the improvement of cotton by seed selection and crossing has had special attention; the particularized nature of the results causes them, however, to be unsuited for recapitulation here: reference is made to the original reports.

MISCELLANEOUS.

The kind of work that has received report annually, in regard to sugar-cane and cotton is thus indicated. For reasons stated already, it will be sufficient to mention the other matters that receive attention in the general Annual Reports for 1906-7 to 1909-10—the only ones of this nature that have been made. These subjects include agricultural shows; agricultural teaching; bee-keeping; cassava variety experiments; Colocasias, trials with; exhibitions in England and Canada; fruit (avocado pears, bananas, mangos) shipments; leguminous plant trials; mangos, introduction of improved varieties; meteorological records; onion industry; plant collection; plant distribution; plant fumigation; stock importation for improvement; sugar-cane transportation for planting; sweet potato shipments; sweet potato variety experiments; yam shipments.

ST. LUCIA.

STAFF.

In 1900-1, when the Station came under the administration of this Department, the Curator, Mr. J. C. Moore, was absent on six months' leave, and during this time the general work of the Station was supervised by the Hon. Alexander Clavier. It was at this period that the work was commenced in connexion with the establishment of an Agricultural School at Union estate, and in the next year, the Curator was removed to that estate, to take up his residence there and enter into charge of the Agricultural School, which by this time had become constituted, the scheme followed being for the Curator to pay visits to the Botanic Station for purposes of administration. In 1901-2, Mr. G. S. Hudson held the post of Agricultural Instructor, and there was no change until 1903-4, at which time the Curator took the title of Agricultural Superintendent. This officer was absent on six months' leave, in 1904-5, when his duties were performed by Mr. F. E. Bundy, for part of the time, and by the Rev. L. Barlow for the remainder of the period. In the same year, leave was granted to the Agricultural Instructor, and Mr. G. A. Deveaux acted in his place. The staff remained the same in 1905-6, when the Agricultural Instructor again received leave for a short time, and his duties were performed by Mr. W. P. Deacon. There were no changes during the next year, but in the following period, 1907-8, Mr. G. S. Hudson resigned, and in 1908-9, Mr. T. D. Worm was appointed in his place. In 1909-10, the Agricultural Superintendent was on leave, and during the time, his duties were taken up by the Agricultural Instructor, and subsequently by Mr. T. L. Marshall, Crown Lands Overseer. It was in this year that the Agricultural Instructor resigned, and assistance in regard to some of his duties was afforded to the Agricultural Superintendent by the Schoolmaster of the Agricultural School, Mr. R. W. Niles. It is convenient to mention that the post of Agricultural Instructor in St. Lucia has since been abolished, and that of Assistant Agricultural Superintendent created, the present holder of this office being Mr. A. J. Brooks, lately Officer-in-Charge of the Dominica Agricultural School.

ORNAMENTAL PLANTS OF STRIKING SPECIES.

An interesting and useful collection of these has been kept and supplemented from time to time, chiefly for purposes of demonstration and distribution. With relation to this and other work at the Botanic Station, trouble has been constantly caused, particularly in connexion with the raising of young plants, through the existence of mole crickets and land crabs, for the control of which unremitting attention has had to be given. A much more serious disadvantage has been in the nature of floods, which have damaged the lawns and walks, and caused the roots of many of the plants to rot. A predisposing cause to the flooding of the Station is the fact that it is mostly situated on made ground very near the sea-level, so that the presence of tidal water in the drains prevents that which arrives as a result of heavy rainfall from running off. As has been indicated, notwithstanding these difficulties, a useful collection of plants, both ornamental and economic, may be seen at the Station.

Before treating of the particularized experimental work, it is necessary to point out that by far the greater part of this, as well as the work of stock and poultry keeping, has been carried out at the Experiment Station attached to the Agricultural School, at Union estate, where the chief experiments were started in 1902-3. It should also be mentioned that, at this station, an extension of the area cultivated took place in 1907-8, chiefly in cacao.

ECONOMIC EXPERIMENTS.

In dealing with the following information, it must be remembered that, as has been pointed out, the experiments were conducted at the Experiment Station attached to the Agricultural School. There has also been a fairly large scheme of experimentation in country districts, directly supervised by the Agricultural Instructor, under the administration of the Agricultural Superintendent.

EXPERIMENTS WITH STAPLE CROPS.

SUGAR. In this connexion, the work has consisted mainly in the growing of canes of useful varieties, for distribution. This assisted particularly toward increased progress in the sugar industry in 1904 and 1905; while in 1906-7, a considerable amount of disease in the Bourbon cane was reported, so that there was an enhanced demand for seedling varieties—chiefly B. 208 and D. 115. The work of distribution has continued steadily, and it is only necessary to make passing reference to attempts which took place on several estates, in 1909-10, to produce fancy molasses—attempts which were finally abandoned.

CACAO. In 1900-1, cacao plots, each about 1 acre in extent, commenced to be worked, for demonstration, by the Imperial Department of Agriculture, the progress being reported upon by the Agricultural Instructor; at the same time plots of cacao trees were kept at the station. The former work was continued during the next year, and a plot of cacao was started at the Agricultural School, which was opened during this period; this plot has been maintained ever since The cacao plots on private estates were continued until 1905-6, when the work done in relation to them by the Department ceased; the results of the experimentation will be found in the Annual Report of the Agricultural Instructor for that year. It should be mentioned, in passing, that in other experiments, the usefulness of green dressings in cacao plantations was demonstrated; at the same time, the work on estates was of much use in influencing planters. and even peasants, to cultivate and drain their plantations properly, and to use basic slag and sulphate of ammonia.

In 1906-7, an entirely new series of experiments, on estates, was started. The report for the next year shows that useful work had been done on these new plots, and that satisfactory progress in relation to cacao-growing was being made at the

Agricultural School; in the report of this year, an account is given by the Agricultural Instructor on cacao diseases in St. Lucia. In 1907-8, the manurial plots on estates were discontinued. The work of this year included the making of arrangements for grafting cacao, and notes are given in the report dealing with investigations of cacao diseases, Success was obtained with grafted plants in 1908-9, and the same is true generally, in regard to the cacao plots at the Agricultural School, up to the end of the period with which this account deals.

LIMES. Lime production in St. Lucia, as well as the two industries which are to be described immediately below, is of a subsidiary nature, but in a progressive condition. Plantings of any extent were first made at the Rivière Dorée Experiment Station, in the country, in 1901-2; and by 1904-5, the effect was to show that lime-planting is not likely to be successful on abandoned sugar estates near the south-west coast of the island. The first shipment of green limes was made from St. Lucia in 1905-6, and it was during this time that the tendency for the adoption of lime-growing by planters began to increase; at the same time, arrangements were being made for establishing plant for concentration of the juice. In 1905-6 also, a plot of limes was established at the Agricultural School, as an object-lesson and for propagating purposes. It was reported in 1906-7 that lime cultivation was receiving considerable attention in the island, and that this was being aided by large distributions of planting material from the nurseries of the Agricultural Department. This distribution has continued to be maintained up to the present.

COTTON. This was planted at the Rivière Dorée Experiment Station in 1901-2, and the trial receives report by the Agricultural Instructor in 1902-3; in the latter year, too, plots containing varieties of cotton were sown at the Agricultural School. The experiments were maintained at the Agricultural School, in 1903-4, and a gin and a baling press were placed there. At the same time, the continuation of the Rivière Dorée experiment had shown that, as in 1902-3, a useful course of manuring for cotton, under the conditions of the experiment, was the application of 1 cwt. per acre of ammonium sulphate, one month before flowering. In 1904-5, lectures on cotton-growing were given by the Agricultural Instructor, in country districts. At this time, experiments at the Agricultural School showed that early planting is best for Sea Island cotton, and this fact was supported by trials at the Rivière Dorée Experiment Station, which also demonstrated that Sea Island is more profitable than Upland, for growing in St. Lucia. The reports for 1905-6 indicate that fair results were obtained with Sea Island cotton, in experimental estate cultivation; the seed-cotton produced under these circumstances was ginned and baled, for the growers, at the Agricultural School Experiment Station. In the next year (1905-6), cotton-growing in St. Lucia continued to be confined to a very small experimental area, and in 1907-8 trials of the crop were resumed at the Experiment Station at the Agricultural School, with fair success. The demonstration plot was continued in 1908-9, and trial plots were also planted in different districts; the effort to extend the area in cotton cultivation was maintained, in addition, by means of lectures given by the Agricultural Instructor. In the Report for 1909-10, the establishment of a cotton industry in St. Lucia is considered to be unpromising (p. 14, par. 10), on account of the circumstance that cotton-growing is not taken up by the principal planters, as well as through the fact of the existence of a small effective labouring population, merely, which exhibits the tendency to give little attention to the requirements of any crop which it may attempt to produce

HONEY. Instruction in bee-keeping has been given continuously at the Agricultural School, mainly with reference to an increasing honey production that is taking place in the colony, and much advice has been afforded by the Agricultural Instructor, from time to time. The growth of the industry is indicated by figures in the reports, which show that the number of colonies in the island increased from seventy, in 1902, to 450, in 1905-6. The amount of honey produced at the Agricultural School has not been great, chiefly because bee keeping has been undertaken there mainly with the aim of giving practical instruction.

EXPERIMENTS WITH PROVISION AND OTHER CROPS.

These were carried out at the experiment station attached to the Agricultural School. In giving the details respecting them, in the following table, there is no inclusion of crops raised for consumption at the school or of those grown for instructional purposes in the boys' gardens.

PROVISION CROPS.	1900–1.	1901–2.	1902–3.	1903–4.	1904–5.	1905–6.	1906–7.	1907–8.	1908–9.	1909–10.
Beans		+		+				+		
Cabbage		+	+	+	+	+	+	+	+	
Carrots		+	+							
Egg plant		+								
Onions		+	+	+			+			
Sweet potatos		+	+	+	+					
Tomatos		+		+						
Yams		+	+		+	+	+	+		
Cassava			+	+	+			+		
Beet			+	+						
Irish potatos				+						
Ochros				+	+					
Yam bean (*Pachyrhizus tuberosus*) ...					+					
Ground nuts		+	+					+	+	
Pigeon peas		+								
CORN AND MILLET CROPS.										
Maize			+	+	+	+	+	+		
Japanese millet						+				
Dhurra						+				
Kaffir corn...						+				
Brown corn						+				
Teosinte						+				

EXPERIMENTS WITH PROVISION AND OTHER CROPS.—*Concluded.*

	1900-1.	1901-2.	1902-3.	1903-4.	1904-5.	1905-6.	1906-7.	1907-8.	1908-9.	1909-10.
GREEN DRESSING CROPS.										
Alfalfa		+								
Cowpeas			+		+					
Bengal bean			+							+
Horse bean			+							
Soy bean			+							
PASTURE AND FODDER CROPS.										
Cowpeas			+		+					
Bhabur grass (*Ischaemum augustifolium*)					+					
Bersim (*Trifolium alexandrinum*) .					+					
Barbados sour grass						+				
Japanese millet						+				
Dhurra						+				
Kaffir corn						+				
OIL CROPS.										
Castor oil plant		+	+							
Ground nuts		+	+					+	+	
Cochin lemon grass								+		
Soy bean			+							

In 1902-3, the value of manuring was demonstrated, particularly for onions and yams, and it was also shown that the latter crop received benefit by the banking of the plants. In regard to onions, by 1903-4 three years' trial had shown that growing with transplantation is the best scheme for St. Lucia. It was during this period that attention was given to the crossing of Antigua varieties of corn with local kinds, and to the introduction of Peruvian maize; success resulted in the former case, but the Peruvian maize was found to be unsuited to the climate of St. Lucia. As will be seen later for Antigua, tomatos which were grown showed susceptibility to the attacks of *Bacillus solanacearum.* It was demonstrated by trials that the best time for planting Irish potatos, in St. Lucia, is in December, so that they will reach maturity during the dry season. In 1903-4, again, experiments were made at the Agricultural School in the production of farine and starch, from cassava grown there. In these, the loss in scraping was found to be 32·5 per cent., and in pressing and baking, 44·5; so that the yield of farine on the fresh roots, was 23 per cent. The starch obtained from fresh roots, by grating and washing, was 12·7 per cent., the roots used in both trials having been dug ten months after planting. In 1904-5 and 1905-6, experiments with yams demonstrated the value of manuring, and the best results were obtained in plots in which short stable and pen manure had been used for a preceding short crop, following by a dressing of lime. In the former of these periods, experiments with cabbages continued to show that the best months for growing the plants in St. Lucia, are between November and March. Trials with yams, in 1907-8, indicate that a definite increase of crop was obtainable by stak~~ing ; in this~~ period, too, experiments with ground nuts indicated that these should be sown so that the succeeding crop will ripen in the dry season, namely between February and May. It may be finally stated that, while the work with such crops as cabbages, carrots and tomatos has been mainly concerned with variety trials, the satisfactory results of the continuous experiments with provision crops have been subsequently repeated.

MISCELLANEOUS CROPS AND SUBJECTS.

The reports for the different years have reference to the following subjects, among others, the time at which they receive attention being indicated after the name of each subject: agricultural shows, 1902-3; arrowroot, 1901-2; bananas, 1904-5 to 1906-7; bee-keeping, 1901-2 to 1908-9; citrus plants 1901 to 1909-10; coffee, 1901 to 1907-8; cotton-ginning, 1902-3 to 1904-5; cotton seed disinfection and distribution, 1904-5; examinations in practical agriculture, 1909-10; grape culture, 1902-3; herbarium, 1901; hybridization (cacao), 1904-5 to 1906-7; insecticides and pests, 1904-5 and 1907-8 to 1909-10; irrigation, 1905-6; kola, 1903-4 to 1905-6 and 1907-8; lectures to teachers, 1901-2, 1902-3 and 1909-10; mangos, grafting of, 1906-7 to 1909-10; mango shipments, 1905-6; millions (the mosquito-destroying fish), 1908-9; new industries, 1909-10; nutmegs, 1902-3 and 1904-5; pineapples, 1901 to 1905-6; plant fumigation, 1906-7, 1907-8 and 1909-10; poultry food plants, 1905-6; prize-holdings competitions, 1909-10; rat virus, 1905-6; rubber, Castilloa, 1902-3 and 1904-5 to 1909-10; rubber, Funtumia, 1904-5 to 1907-8; rubber, Hevea, 1906-7 to 1909-10; rubber, Manihot (Jequié and Remanso Maniçoba), 1908-9 and 1909-10; school gardens and agricultural teaching in elementary schools, 1902-3, 1904-5, 1905-6, 1908-9 and 1909-10; shade trees, 1904-5 and 1905-6; soil examination, 1909-10; vanilla, 1901, 1901-2 and 1904-5 to 1906-7.

As a large amount of work has been done in relation to the introduction of rubber-producing plants, a résumé of the information regarding this, which is available in the reports, is gven here. In 1902-3, the cultivation of the soil, for Castilloa, was found much superior to the cutlassing of grass and weeds, and further trial in 1909-10 supported the experience of that year. It is stated that these plants were making satisfactory progress in 1904-5. During the next year, trees of Castilloa were tapped at the Botanic Station, and on one estate, with successful results (see *Agricultural News*, Vol. IV, p. 382, and *West Indian Bulletin*, Vol. VII, p. 21); it was during this time that the growth of the trees of this kind at the Agricultural School was checked by attacks of scale insects. In 1906-7, tapping experiments with Castilloa at the Botanic Station, seemed to indicate that the spiral method is the most expeditious; seeds from the trees with which the experiments were made were distributed in the island. In this year, experiments for the control of scale insects on Castilloa were made at the Agricultural School, and the report for the period contains an account, by the Agricultural Instructor, of tapping experiments in country districts. In 1907-8, a useful crop of seeds was obtained, and this was employed for raising plants and for distribution. A final matter in connexion with Castilloa is that exhibits of the rubber obtained from trees in the island were sent to the International Rubber Exhibition, held in London in September 1908; the report on these is contained in the account of the work of the Station for 1908-9. The Report for 1904-5 states that trees of Funtumia planted at the Station in 1901 were making good progress, and that one specimen was fruiting; in 1905-6 all these trees flowered, and some produced fruits, and it was in this year that a plot of Funtumia plants was made at the Agricultural School, using bananas and tanias as shade. As regards Hevea, the Report for 1906-7 states that the importation of seed from Ceylon, for planting purposes, was a failure Success was obtained, however, in the next year, particularly with seeds (from the same origin) packed in slightly damped charcoal dust that became dry in transit. In 1908-9, plants raised from this seed were placed out at the Agricultural School Experiment Station, and in 1909-10 these had made very irregular growth on account of some unknown cause. A final matter in regard to rubber is that plants of Jequié and Remanso Maniçoba rubber (*Manihot dichotoma* and *M. piauhyensis*) were raised from seed which had been received from the Commisssoner of Agriculture, and in 1909-10 these were set out at the Botanic Station.

Other matters of interest concern the stock kept at the Agricultural School (see special report); attempts in 1904-5 and 1905-6 made in connexion with a proposed export trade in bananas, to England; and a scheme for prize holdings competitions, drawn up in 1909-10.

DOMINICA.

STAFF.

In the period 1899-1900, an Agricultural Instructor was appointed in the person of Mr. G. F. Branch, the Curator of the Botanic Station at that time being Mr. Joseph Jones, who continues to hold this appointment. At the Agricultural School, opened in December 1900, the Officer-in-Charge was Mr. D Tannock. There were no changes in 1901-2, but in 1902-3, the last mentioned officer was granted leave and his duties were carried out by the Curator, assisted by Mr. Penn, the schoolmaster at the Agricultural School, who also acted in the next year during the interval for the appointment of Mr. A. J. Brooks as Officer-in-Charge, in the place of Mr. Tannock, as the latter had resigned in order to take up an appointment in New Zealand. The Curator of the Botanic Station was granted leave in 1904-5, when his work was done by the Officer-in-Charge of the Agricultural School and the Agricultural Instructor. In the next year, the latter officer was transferred to Grenada, in the same capacity. No changes took place in 1906-7, save that the duties of the Curator, during his absence at the Agricultural Conference in Jamaica, were undertaken by the Officer-in-Charge of the Agricultural School; a similar arrangement was made for the Agricultural Conference in Barbados, in 1908. A change was made at the Agricultural School in 1907-8, when Mr. J. Angol succeeded Mr. Penn as schoolmaster; meanwhile the post of Agricultural Instructor remained vacant. In 1908-9, leave of absence was granted to the Curator, and his duties were performed by the Officer-in-Charge of the Agricultural School; in the same period Mr. Angol was succeeded by Mr. Benoit as schoolmaster at this institution. The post of Agricultural Instructor was not continued but, in 1909-10, Mr. G. A. Jones was appointed to the newly constituted post of Assistant Curator, and acted for the Officer-in-Charge of the Agricultural School, during a period in which he was in receipt of leave.

ORNAMENTAL PLANTS OF STRIKING SPECIES.

A brief historical sketch of the Dominica Botanic Station given in the Report for 1906-7 shows that this was established in 1891, and information in addition to what is afforded here may be obtained by consulting this account. The conditions for plant-growing and experimentation are favourable in the larger part of the Station, as the soil is good and there is an abundant supply of water. The purpose kept in view in maintaining the Station has been the making of economical and experimental trials with plants, while at the same time ornamental plants are grown in moderate quantities, mainly for the purpose of demonstration and of increasing the attractiveness of the grounds. During the whole time of its existence, a large amount of attention has been given to the introduction of economic plants, and these have been mainly obtained from Kew and from the interesting collection already in existence, when it was established, at St. Aroment, the property of Dr. H. A. A. Nicholls, C.M.G., which has itself had its origin mainly in Kew. As regards the garden the chief object has been the production and distribution of useful economic plants, and some idea may be obtained of the growth and extent of this work from the fact that such distribution has increased from 9,000 plants yearly in 1891 to about 80,000 in recent years.

A list of the plants growing at that time, at the Dominica Botanic Station is given as an appendix to the Report for 1907-8.

ECONOMIC EXPERIMENTS.

EXPERIMENTS WITH STAPLE CROPS.

LIMES. The Report for 1899-1900 shows that spineless limes (see *Agricultural News*, Vol. I, p. 38) were being raised and that it was found that, in planting, 80 to 90 per cent. of the seeds of his variety came true. The work with spineless limes has been steadily continued since, and in the Report for 1901-2 an account is given of an investigation undertaken for the purpose of comparing the juice of the spineless lime with that from the ordinary fruit. In relation to the progress in the lime industry, the period 1902-3 saw a demonstration of the manufacture of citrate of lime, given by Dr. Francis Watts, C.M.G., the present Imperial Commissioner of Agriculture, at the Bath estate, which was kindly lent, with the necessary materials, by the Attorney of the estate; the product was dried in the cacao drier which had been erected at the Station in the previous year, and a favourable report was received concerning samples sent to England. It is noted, in 1903-4. that the plot of limes at the Agricultural School remained free from attack, owing to its vigorous condition, during an epidemic of scale insects and black blight in the island. In the report for the next year a reference is made to lime plots which were being maintained in country districts. The constitution of the juice of spineless and of ordinary limes again receives attention in 1905-6, and it is to be noted during this year that the lime plant distribution from the Agricultural School was increasing. In relation to the latter institution, it should be mentioned that the trees in the lime plot attached to this (as well as those in the cacao plot) have been particularly useful as affording material for the practice of pruning, by the pupils. The Report for 1906-7 contains special information concerning the spineless lime, comparing it with the ordinary kind; at this time manurial experiments with limes, commenced in 1903 at St. Aroment estate, owned as is stated above by Dr H. A. Nicholls, C.M.G., receive special notice, and this is given in subsequent reports as well. Lastly in regard to 1906-7, the report for the period contains information concerning the export of lime products from 1892 to 1906, and records the first shipments of citrate of lime from Dominica. (General information concerning citrate of lime may be found in the *West Indian Bulletin*, Vols. II, p. 308; III, p. 152, ; VII, p. 33 and VIII, p. 167.) In the Reports for 1907-8, 1908-9 and 1909-10, information is given concerning the crop of spineless limes at the Botanic Station, and the first of these presents a short account of the progress of the citrate of lime industry, in Dominica; that for 1909-10 contains details of an investigation begun for the purpose of finding if the acidity of the spineless lime can be increased by chemical selection (see '*Agricultural News*, Vol. IX, p. 260). The last two reports with which this account deals also afford information concerning the general state of the lime industry of the island. A final matter is that the appointment of an Assistant Curator, in 1909-10, led to arrangements being made for the testing of lime juice at the Botanic Station.

CACAO. In 1899-1900, five manurial plots were established, at the Station, in addition to others already existing, and since the plants have been old enough to bear, careful accounts of results have been published in the reports, year by year. These should be consulted if detailed information is required, and this is also obtainable from the *West Indian Bulletin*, Vols. VI, p. 258; VII, p. 201; VIII, p. 131; IX, p. 138 and X, p. 175; the second and fourth of these references to the *West Indian Bulletin* also contain an account of the manurial experiments in country districts, established at the same time and reported on regularly ever since. It will be convenient to indicate, without description, the general results of these two series of experiments. Up to the end of the period that is being dealt with, the manurial experiments at the Botanic Station have shown that, under the conditions, the best results are obtainable by applications of grass and leaves, used as a mulch merely, and not turned into the soil; the next best results were obtained from the employment of a complete manure consisting of dried blood, basic phosphate and sulphate of potash. The work in country districts was reported upon, in 1901-2, by Mr. G. Whitfield Smith, Travelling Superintendent of the Imperial Department of Agriculture, and in 1902-3 to 1904-5, by the Agricultural Instructor; in the next year, the results were given, simply, without report, and since that time, a more detailed annual description of the trials has been presented by the Superintendent of Agriculture of the Leeward Islands. In the different divisions of these experiments, the following general results are deducible. under the particular conditions: (1) applications of dried blood, and of basic phosphate, together with the bedding in of the grass and weeds produced in the plots, have shown much the same result; (2) that cacao can be grown successfully on the flat land which is available in one of the districts (Picard) for the purpose; (3) experiments on a large scale, conducted with the co-operation of Messrs. Rowntree of York, are indicating up to the present the usefulness of pen manure in cacao cultivation as well as of a mixture containing basic phosphate and sulphate of ammonia, applied in conjunction with cotton seed meal. A plot is being maintained (at Riversdale) which was planted in March 1903 on forest land about 9 miles from the coast, the purpose of the experiment being to gain information as to the results obtainable from cacao, with proper cultivation, in such a situation. It should be mentioned that the work on the plots in country districts is conducted with the cooperation of various planters, and with that of the firm whose name has just been given. Returning to the chronological presentation of cacao matters in Dominica, it is of interest that Alligator cacao (*Theobroma pentagona*) was introduced into Dominica, in 1899-1900, from Trinidad, with the assistance of the late Mr. J. H. Hart; by 1902-3 the plants had fruited, and at this time another plot was started, the seed for this also being obtained from Trinidad. It was in this year also that plants of Ocumare cacao were raised at the Station. In 1903-4, the plants of Alligator cacao just mentioned began to show susceptibility to canker. It is in 1905-6 that reference is first made in the reports to attempts in the direction of grafting cacao by approach; success is recorded with Alligator on Forastero, and the usefulness of the latter and of Calabacillo as stocks is demonstrated. It is worthy of mention that in the meantime, a model cacao drier was erected at the Station in1901-2; this is described in the Report for that period. In 1906-7, the progress in the grafting of cacao was continued; in the report for this period, particulars may be found of the exports of cacao from the island for the years 1892 to 1906. Further progress with the grafting of cacao is indicated in the Report for 1907-8 (see also *West Indian Bulletin*, Vol. VIII, p. 137; IX, p. 149, and Pamphlet No. 61 of the Department Series). It was during this period that a new series of cacao experiments was commenced at the Botanic

Station, dealing with the effects of mulching, and manuring with cotton seed meal, and of mulching cacao land on steep slopes; by 1909-10, these trials had appeared to show the advantage of the use of mulches, for cacao, on hillsides, as well as on the flat. A further matter of record for 1907-8 is that the cacao plot at the Agricultural School, which was started in 1902, was extended to twice its original size. The Report for 1908-9 records continuous success in grafting cacao and the putting out of a large number of plants of the best kind for providing material in the future; this work with the grafting of cacao has been steadily continued since at the Botanic Station and the Agricultural School. It is at this time that a special report is given on an actual example showing the good effects of draining cacao, and the report for the period further contains a special account of the cacao plots at the Agricultural School, the first of which had now come into bearing. Finally, it may be mentioned that the Reports for 1904-5 and 1906-7 to 1908-9 give particulars concerning the crop of cacao at the Botanic Station, and that those for 1908-9 and 1909-10 present an account of the state of the cacao industry in Dominica at the time at which they were made.

EXPERIMENTS WITH PROVISION AND OTHER CROPS.

As in the case of St. Lucia, the trials af this nature have been carried out chiefly at the Agricultural School. Similarly, in giving the results, no inclusion is made of plants that were raised solely for consumption in this institution.

The following are the plants concerning which information is given:—

PROVISION CROPS.	1900-1.	1901-2.	1902-3.	1903-4.	1904-5.	1905-6.	1906-7.	1907-8.	1908-9.	1909-10.
Onions	+	+	+	+	+					
English vegetables	+	+	+	+	+	+				
Yams...		+	+	+	+					
Sweet potatos		+	+	+						
Tanias		+								
Pigeon peas		+		+	+					
Yam bean (*Pachyrhizus tuberosus*) ...					+	+				
Cassava						+				
Ground nut								+	+	+
CORN AND MILLET CROPS.										
Guinea corn		+	+			+	+	+	+	+
Imphee		+	+							
Broom corn (*Andropogon Sorghum*, var. *technicus*)								+		
Various dhurras								+	+	+
Various sorghums								+	+	+

EXPERIMENTS WITH PROVISION AND OTHER CROPS.—*Concluded*

	1900-1.	1901-2.	1902-3.	1903-4.	1904-5.	1905-6.	1906-7.	1907-8.	1908-9.	1909-10.
GREEN DRESSING CROPS.										
Pigeon peas		+		+	+					
Alfalfa		+				+	+			
Woolly pyrol							+			
Horse bean (*Canavalia ensiformis*) ...								+		+
Soy bean										+
Sword bean (*Canavalia gladiata*) ..										+
PASTURE AND FODDER CROPS.										
Guinea grass		+					+	+	+	+
Imphee		+	+							
Alfalfa		+				+	+			
Guinea corn		+	+			+	+	+	+	+
Jerusalem corn							+	+	+	
Various dhurras								+	+	+
Teosinte								+	+	
Para grass								+	+	+
Various sorghums								+	+	+
OIL CROPS.										
Citronella grass				+						
Ground nut								+	+	+

The earlier reports contain particulars of trials with onions, both at the Botanic Station and at the Agricultural school and success is indicated with these, as well as with trial shipments of the onions. A large series of experiments has also been made with English vegetables for the purpose of ascertaining the best varieties for cultivation, and the way in which they should be grown, in Dominica; success was not met with at first but the later trials have been encouraging. except for the fact that several failures have been recorded in regard to the growing of Irish potatos. Interesting results with pasture and fodder crops have been obtained from year to year. In 1901-2, and in the next year, imphee is reported as being superior to Guinea corn as a fodder, because of its greater hardiness and the fact that the seed is not eaten by birds. In 1905-6, seeds of improved Guinea corn (Bascom and Improved Bascom) were received from the Commissioner of Agriculture, and these exhibited promise in that year as well as in the next, when Bascom Guinea corn showed itself as a valuable forage plant for dry situations, while improved Bascom Guinea corn, on account of its height, appeared to be useful for sheltered places, only. The experiments at this time indicated that Jerusalem corn is one of the surest fodder crops for dry situations, as it produced yields when other plants were perishing from drought. An extension of the experiments with fodder crops was made in 1907-8 and has continued up to the present; its purpose is to find out the amount of green fodder yielded by the different plants under trial, during the dry season, namely from January to June. As in some of the other islands trials with Peruvian maize, received from the Commissioner of Agriculture in 1903-4, resulted in complete failure. With reference to yams, a trial of late planting, in 1904-5, gave unsatisfactory results. In 1919-10 a comparison of *Canavalia ensiformis* and *C. gladiata* as green dressings was made, when the former was found to be the better plant for the purpose (see *Agricultural News*, Vol. IX., p. 37). The soy bean was introduced for trial in 1909-10. The year 1905-6 witnessed tests of cassava from Monstserrat and Jamaica; the better kinds were those from the former island; farine made from these gave a yield of 14 per cent. on the weight of the roots taken, as well as a certain amount of starch. Experiments with alfalfa, made in 1905-6 and 1906-7, included trials of this plant in conjunction with tests of cultures of nitrogen bacteria from the United States Department of Agriculture, and with nitragin; there was an increased yield favouring the use of the former, but with nitragin the experiments were accidently lost. Trials with ground nuts in 1907-8 obtained success with the varieties Dixie Giant, Tennessee Red and 'African'. Of the varieties tried in the next year, Spanish gave the best yield, of a nut smaller than the others and having a more ready local demand. The experiments were continued in 1909-10, and information is given concerning ground nut diseases in Dominica, as well as a description of experiments which appeared to demonstrate the usefulness of liming the soil for ground nuts, under the conditions of the experiments. It may be mentioned that information concerning ground nuts in the West Indies, including Dominica, may be also found in the *Agricultural News*, Vols. VII, p. 117; and VIII, pp. 206 and 404; as well as in the *West Indian Bulletin*, Vol. XI. p. 161.

Miscellaneous Crops and Subjects.

Among the chief matters that have not received attention in the presentation of the foregoing facts are the following, with the dates of the Reports in which they may be found: Agricultural Experiments Committee, 1906-7 and 1907-8; agricultural implements, 1901-2; agricultural shows, 1903-4 to 1905-6; Assistant Curator, work of, 1909-10; bananas, cultivation and export, 1899-1900, 1901-2, 1902-3 and 1904-5 to 1906-7; bee-keeping, 1902-3 to 1909-10; camphor, 1902-3; citron peel shipment, 1904-5; coffee, 1901-2 to 1903-4 and 1908-9; cotton, 1903-4; Courses of Reading and Examinations, 1909-10; crops cultivated for consumption at the Agricultural School, 1899-1900, 1902-3 to 1904-5 and 1906-7; date palm, 1907-8; Eucalyptus, 1909-10; exhibitions, Canadian, 1901-2, 1902-3, 1904-5 and 1906-7 to 1909-10; exhibitions, International Rubber, 1908-9; exhibitions, Royal Horticultural Society's, 1904-5 and 1906-7 to 1909-10; fruits for preserving, 1905-6; fumigation of imported plants, 1903-4 to 1905-6; ginger, 1901-2 and 1902-3; gommier resin, 1904-5; grape fruit, growing and shipment, 1902-3 to 1904-5 and 1909-10; insects and insecticides, 1903-4, 1906-7 and 1909-10; kola, 1903-4 to 1905-6; lectures to teachers, 1899-1900; lemons, 1902-3, 1905-6, 1906-7 and 1908-9; lists of boys trained at the Agricultural School, 1904-5 to 1909-10; mangos, grafted, 1903-4 to 1909-10; manila hemp as cacao shade, 1901-2; oranges, 1902-3, 1903-4 and 1905-6 to 1909-10; oranges, budded, 1902-3 and 1904-5 to 1908-9; Permanent Exhibition Committee, 1906-7 to 1909-10; *Pilocarpus* *pinnatifolius*, 1906-7 and 1909-10; pine-apples, 1899-1900, 1901-2 to 1904-5 and 1906-7; plant diseases, 1907-8 and 1909-10; poultry, 1899-1900 and 1902-3 to 1909-10; Prize-holdings Competitions, 1908-9 and 1909-10; rat virus, 1905-6; rubber, Castilloa, 1899-1900, 1902-3 to 1905-6, 1907-8 and 1908-9; rubber, Funtumia, 1899-1900, 1902-3 to 1905-6, 1907-8 and 1908-9; rubber, Landolphia, 1903-4 and 1908-9; rubber, *Manihot* spp., 1908-9; rubber, Para, 1903-4, 1905-6 and 1907-8 to 1909-10; rubber, *Sapium* spp., 1908-9; rubber plants, various, 1908-9; school gardens, 1904-5 to 1906-7; soil analysis, 1901-2; stock, 1899-1900, 1902-3 to 1909-10; sugar-cane, 1904-5; tobacco, growing and curing, 1901-2 and 1902-3; vanilla, growing and curing, 1901-2, 1902-3, 1904-5 and 1905-6.

The attention that has been given to rubber plants at the Dominica Botanic Station and Agricultural School makes it necessary that a summary shall be presented of the principal matters concerning these that occur in the Reports. In regard to Funtumia rubber, the statement is made that trees existing at the Station in 1899-1900 were making good progress; this was the case in the following year, when seeds from these trees were distributed in the island as well as in other parts of the West Indies. This progress was made in spite of the fact that the plants were growing in poor and dry soil; they were, however, practically all destroyed in a gale, in 1903-4, and a new plot was started in a more sheltered position. In this year, Funtumia was planted, together with Castilloa, on the Crown lands on the Imperial Road, up to an elevation of 1,700 feet; at the same time plants were put in at the Agricultural School and in the following year the latter were reported to be making good progress, while those on the Imperial Road were already giving indications that Funtumia and Castilloa grow best on light well-drained soils; in relation to this, by 1905-6 these plants had shown that Funtumia grows better than Castilloa on wet soils. Reports were obtained in 1905-6, on samples of rubber from Funtumia, and these showed that the product was not satisfactory in quality, probably because the trees were too young for tapping (six years old). Continued success with this species was obtained at the Agricultural School, and in the period mentioned last the area of Funtumia at that institution was increased. In 1907-8, although the yields from tapping were always unsatisfactory, samples of Funtumia rubber (together with others of Castilloa) were despatched to London for report, and were pronounced to be inferior to those of Para sent at the same time

The information available concerning Castilloa rubber shows that trees old enough for tapping were in existence at the Station in 1899-1900. In 1902-3, as with Funtumia, seed from the trees was distributed in Dominica and in other parts of the West Indies. The gale of the next year, which has been stated already to have destroyed most of the Funtumia trees, did not cause any injury to the Castilloa plants, and in consequence the use of the latter as shade trees was suggested. As has been stated already, when dealing with Funtumia, Castilloa was planted near the Imperial Road, up to an elevation of 1,700 feet; during the same period a tree at the Station was tapped, and samples of the rubber were sent for examination to London and New York. Tapping of Castilloa was again done in 1904-5, and samples were forwarded to England, when a favourable report was received, as was the case in the previous year. Castilloa rubber was also sent away for report in 1905-6, 1907-8 and 1908-9, when favourable results were obtained, though as has been stated, the samples sent in 1907-8 were declared to be inferior to those of Para despatched at the same time. In 1908-9, a plot of Para and Castilloa plants, with cacao, was established at the Agricultural School, and it was in this period that samples of Castilloa rubber were sent to the International Rubber Exhibition.

Para rubber is first mentioned as having been planted near the Imperial Road, in 1903-4. Two years later (in 1905-6), it was estimated that there were only about twenty-five trees of Para in the island, of which fifteen were at the Botanic Station, and it is stated that seeds were being obtained from Ceylon through the Commissioner of Agriculture. It was in 1907-8 that Para rubber trees were first tapped in Dominica, and a favourable report was obtained for rubber sent to London—a report that, as has been indicated was better than those for Castilloa and Funtumia rubber sent from the Botanic Station at the same time; for coagulating the Hevea latex, lime juice was employed. Hevea seeds were imported from Ceylon in 1907, and a germination of 80 per cent. was obtained although some of the seed had commenced to sprout during the journey. Other importations of Hevea seed into Dominica have been from Singapore, in 1908-9 and 1909-10, the quantities being 2,000 seeds (besides 6,000 for planters), in 1908-9, and 32,000 in 1909-10; in both cases the germination was about 50 per cent. Returning to the consideration of the plants, two more small plots were started at the station in 1908-9, and at this time experiments showed Hevea to be easier to tap than Castilloa, Funtumia or Ficus; while samples of the rubber examined at the Imperial Institute received satisfactory report, and this was the case with others forwarded to the International Rubber Exhibition of 1908. The demand for plants and seeds of Hevea had become considerable in 1909-10, by which time it was demonstrated that Hevea will thrive in the wet districts of Dominica and that the prospects of cultivation in the island are distinctly good; no tapping was conducted during the year, but arrangements were being made for the systematic tapping of both Hevea and Castilloa.

Of other rubbers, Landolphia is reported on in 1903-4 and 1908-9, the species in the gardens being *L. owariensis* (the rubber vine), *L. madagascariensis*, *L. Klainii* and *L. sphaerocarpa*. In 1908-9, Ceara rubber is reported to have been introduced into Dominica many years before, but that it had met with a poor development; seeds of other Manihots namely *M. dichotoma* and *M. piauhyensis* were received from Kew during this year. In the same period, it is reported that Assam (Rambong) rubber had been existent in Dominica for many years, but that its cultivation had not spread owing to the extent of its interference with the growth of other plants. In 1908-9, too, *Sapium aucuparium* and *S. Jenmani* are mentioned as growing in the Gardens, and in the same year an attempt, which proved unsuccessful, was made to introduce the Virgen rubber of Columbia (*Sapium* sp.), from planting material received from the Imperial Commissioner of Agriculture. The miscellaneous rubber plants in the gardens include *Mascarenhasia elastica* from Kew, Ecanda rubber' (*Raphionacme utilis*—from Kew), *Alstonia scholaris*, *Odontadenia speciosa* and *Cryptostegia grandiflora*.

Other matters may be given attention as follows. In regard to oranges, a plot was made in 1905-6, at the Agricultural School and extended in 1906-7; while regular reports of an orange plot at Corona estate have been given since 1903, and the plants in this now form a reserve from which budwood of the best varieties of citrus trees may be obtained for propagating purposes. These are only two out of the many considerations in regard to citrus plants. Reports on the stock and poultry have been made regularly; as regards the latter there was little progress until 1906-7, owing to the ravages of diseases and enemies, but an incubator was introduced at that time by the Imperial Commissioner of Agriculture, and in the Report of this year there occurs a detailed account of the poultry at the Agricultural School. Finally, the reports on vanilla growing and curing indicate general good success, that of 1905-6 drawing attention to the particularly favourable prospects for this plant in Dominica; while in reference to Eucalyptus, the Report for 1909-10 contains a list of the trees that are forming the subjects of definite trial.

MONTSERRAT.

STAFF.

In 1900 Mr. A. J. Jordan, from Kew, was appointed as Agricultural Instructor for Montserrat. Later, a Local Instructor, in the person of Mr. D. Johnson was also appointed; this officer was expected to give only a portion of his time to the duties of the post, and reports were furnished by him in the years 1902-3 to 1906-7. The Local Instructor resigned in 1907-8, and the office was abolished; his report for the period was furnished by the Curator. In 1903-4 the Agricultural Instructor was first designated Curator, and in the next year, Mr. Jordan resigned to take up the position of Curator of the Antigua Botanic Station, in succession to Mr. W. H. Patterson. Mr. W. Robson was appointed from Kew, in 1905-6, to the post of Curator, and holds the office at the present time. The remaining circumstance for note is that Mr. Maloney acted for Mr. Robson during his absence on leave in 1908-9.

ORNAMENTAL PLANTS OF STRIKING SPECIES.

The first efforts of the present agricultural organization in Montserrat were made in connexion with the giving of hurricane relief after the great storm of 1899; these were continued at the experiment stations established in 1901 at the Grove estate, Harris's Village and Olveston. The work at these stations rapidly increased, and became more general in character; they are still being maintained, with the exception of that at Olveston which was abandoned at the end of 1909-10, as the soil was not found suitable for the purpose for which the station was intended, namely of experiments in connexion with the growing and spread of cultivation of garden crops. The Grove Station is the only one at which ornamental plants and examples of useful permanent crops have been kept to any extent; it has thus the chief claim to the name Botanic Station, while Harris's Station is used mostly for experimental work and chiefly ministers to the needs of the peasantry.

ECONOMIC EXPERIMENTS.

EXPERIMENTS WITH STAPLE CROPS.

LIMES. The report for 1901 mentions that a hedge of lime plants was established at the Grove Station in that period; in 1903-4, this was in bearing and yielded 22½ gallons of fruit from 100 running feet of the hedge. In 1904-5, the first mention occurs of the usefulness of Bengal beans in the control of scale insects, the observation having been made in one of the fields belonging to the Montserrat Company. Green limes are first referred to, as being exported on any scale, in 1905-6; at this time spineless limes were planted at Grove and a few plants at Harris's and are recorded as commencing to fruit in 1907-8. In 1906-7, seedless limes were found on the property of the Montserrat Company, and steps were taken for obtaining material for propagating the kind. Experiments in lime cultivation and spraying were commenced with the co-operation of the Montserrat Company, in 1907-8; these are being continued at the present time and received their latest summary in the *West Indian Bulletin*, Vol. XI, p. 39. Experiments in transplanting lime trees are mentioned in 1909-10 and are given a preliminary description in the *West Indian Bulletin*, Vol. XI, p. 51. At this time a sample of oil was distilled from lime leaves and sent to the Imperial Institute for examination; the trial showed that the leaves yielded about 0·2 per cent. of their weight, of oil. Lastly the records showed that the number of lime plants (besides seed) distributed in the years 1901-2 to 1909-10 was 57,304.

COTTON. Trials of various kinds of Sea Island and Upland cotton are first recorded in 1901-2 and 1902-3. In the next year experiments made for the control of leaf-blister mite showed that the best results were obtained by the use of sulphur and lime (see *Agricultural News*, Vol. III, pp. 42 and 154). The number of persons growing cotton in Montserrat at this time was about seventy, and although the crop was small on account of black boll and leaf-blister mite, 27,600 ℔. of lint was shipped. The experience with sulphur and lime against leaf-blister mite, already mentioned, was repeated in 1904-5, and in this year manurial experiments are recorded; while the report for the period contains details of the condition of cotton cultivation on estates and groups of estates; the export of lint had reached 70,758 ℔., and there were about 600 acres in cotton in the island. In 1905-6, the experiments included trials with varieties of Sea Island cotton, when cotton grown from St. Vincent seed was found to be of very good quality. The work included manurial trials, and for the general planting the seed was all taken from the previous year's crop and disinfected at Grove. By this time the shipments had reached 98,262 ℔. Planting distance trials were carried out in 1906-7, 1907-8 and 1908-9, when those in the first two years indicated the usefulness of fairly close planting. At the same time seed selection experiments were commenced; these have continued since, being conducted according to the methods described in the *West Indian Bulletin*, Vol. IV, p. 208. The amount of lint shipped in 1906-7 was 160,000 ℔., from an estimated area of 1,050 acres; part of the extension was due to the planting of cotton instead of pine-apples, as the want of regular steamer communication effectually prevented the latter from being a remunerative crop. In this year, as in others, experiments at Olveston Station showed that cotton was not suited to land of the kind existing there. In 1907-8, besides the matters already mentioned, an experiment was made in the surface cultivation of cotton, while trials of planting clean black seeds and fuzzy seeds showed that the elimination of the former, in selection,, would reduce the rate of incidence and thus operate in the direction of the improvement of the lint. The acreage at the period was 2,100, from which 360,000 ℔. of lint was obtained. In 1907-8, too, a commencement was made of a definite series of cotton manurial experiments. These are continuing to show that proper cultivation and the ordinary manurial treatment of the land for keeping it in good heart are all that is required at present for successful cotton-growing in Montserrat; particulars of these experiments will be found in the *Agricultural News*, Vol. IV, p. 263; and in the *West Indian Bulletin*, Vol. 6, p. 247; VII. p, 283; X, p. 209; and XI, p. 60. The area in cotton cultivation in 1908-9 was about 2,250 acres, yield for export 224,711 ℔. of lint. The later reports, including that of 1909-10, contain greater details concerning selection, as time goes on. The area in cotton in the last mentioned period was about 1,700 acres, and the Report shows that the amount of lint shipped to the end of June 1910 was 235,021 ℔. In regard to the distribution of seed for cotton-growing, this amounted in the years 1902-3 to 1904-5 to 5,787 ℔., reckoning 2,939 ℔. imported for use in the island in the last mentioned period. In 1907-8, the distribution amounted to 9,000 ℔., and in 1909-10 there is the record of the sending out of 90 ℔. of pedigree cotton seed.

SUGAR. No manurial or seedling variety experiments have been conducted in Montserrat; the work has been concerned chiefly with the raising of cuttings of imported varieties for distribution, and in 1908-9 an account was given of the seedling varieties that were being grown for the purpose. The records show that the distribution in 1900-1 to 1903-4 was 102,191 cuttings, and in 1907-8 to 1909-10, 18,627 cuttings.

PAPAIN. In connexion with the papain industry, trials were made in 1902-3 for the purpose of comparing native and Grenada varieties of the papaw tree, when it was found that the chief advantages of the latter kind were their earlier fruiting and the production of fewer 'male' trees. In the following year, large shipments of papain from the East began to reduce prices, and this condition obtained in 1904-5 and onwards until 1907-8 when they increased somewhat; this improvement has only been small and has not sufficed to restore the industry to its former importance. The conditions have been that, in 1904-5, purchasers of the crude juice had almost suspended operations; in 1905-6 intermittent purchases were made of the raw juice at half the price of two years before; while in 1906-7 the export had fallen to 2,304 lb., whereas it had been as high as 3,470 lb. In the last mentioned year, a sample of leaves was sent to Messrs. Burroughs, Wellcome & Co., for analysis, and in 1908-9 an experiment was made on the yield of the leaves. The distribution of plants (besides seeds) in 1901-2 to 1903-4 was 2,956; the similar figure for 1907-8 to 1909-10 was 2,609.

ONIONS. Experiments in 1900-1 showed that this crop was not suitable to light soils, without irrigation; in the next year, the shortness of the seed supply caused plants to be raised by the Agricultural Department for distribution; this distribution (together with the plants grown for the use of the Department) amounted in 1902-3 to over 37,000 plants, and in addition 111 lb. of seed was sent out. In this year manurial and inter-crop experiments were made, onions were grown for providing sets, and trials were conducted which showed that direct sowing and subsequent thinning out was a better procedure than transplantation, under the conditions. The distribution of onion plants in 1903-4 reached 32,545; manurial experiments were continued; the island crop was small, however, on account of excessive rains in November and December. The distribution in the next year was 19,400 plants, and the continuation of the manurial experiments still indicated the usefulness of manuring. The experience with manures was the same in 1905-6, and in the Report for this year, useful hints are given on the cultivation of onions in the West Indies. The details given in 1906-7 show that 120 lb. of onion seed was sold from the Station; trials were made of green dressings for onions, and other experiments demonstrated that onions are not suited for growing in clay soils of a fairly stiff nature; the latter trials were repeated in 1907-8, together with continued manurial experiments, and an attempt to grow onions in the dry season, which proved a failure. The onion seed imported in 1909-10 amounted to 140 lb. and in this season the manurial experiments were continued. A final matter is that the reports show that the number of crates or barrels of onions exported, from 1902-3 to 1906-7, was 1,422.

EXPERIMENTS WITH PROVISION AND OTHER CROPS.

Experiments with these have been carried out at all the stations, and plots were kept, in addition, mainly for obtaining material for distribution, principally at Harris's and Olveston Stations. The particulars are as follows:—

PROVISION CROPS.	1900-1.	1901-2.	1902-3.	1903-4.	1904-5.	1905-6.	1906-7.	1907-8.	1908-9.	1909-10.
Yams	+	+	+	+	+					+
Ochros	+									
English vegetables	+	+		+			+	+		
Sweet potatos		+	+	+	+	+		+	+	+
Ground nut		+				+	+	+	+	+
Lima beans		+								
Cowpeas	+	+						+	+	
Pigeon pea		+	+				+	+		
Cassava		+	+		+	+	+	+	+	
Eddos			+	+	+					
Tanias				+	+	+	+	+	+	+
Yam bean							+			
Bonavist bean								+		
Beans and peas, various								+	+	
CORN AND MILLET CROPS.										
Maize	+		+					+	+	+
Guinea corn	+	+	+	+						
Broom corn					+	+	+	+		
GREEN DRESSING CROPS.										
Bengal bean	+		+							
Velvet bean	+		+							
Cowpeas	+	+						+	+	
Alfalfa		+	+	+	+					
Lima beans		+								
Pigeon pea		+	+				+	+		
Sesbania spp.		+	+							
Dwarf horse bean								+		
Climbing Jamaica bean								+		
Climbing bonavist bean								+		

PROVISION CROPS.	1900-1.	1901-2.	1902-3.	1903-4.	1904-5.	1905-6.	1906-7.	1907-8.	1908-9.	1909-10.
PASTURE AND FODDER CROPS.										
Guinea corn	+	+	+	+						
Alfalfa		+	+	+	+					
Pennisetum cenchroides								+		
OIL CROPS.										
Ground nut		+				+	+	+	+	+

Experiments with Bengal beans, velvet beans and cowpeas, in 1900-1, showed that the yield of green matter from the first two, for the first six months of growth, was approximately the same; the advantage was with Bengal beans for longer periods; while cowpeas proved to be a good short green dressing crop. In the next year, manurial and distance experiments with yams appeared to indicate that the best yields were obtained with manuring and close planting. The benefits of manuring were also shown for Guinea corn, in 1903-4. Experiments conducted in 1904-5 demonstrated the benefit of liming, for alfalfa. During this period material was distributed, for planting, that had been raised from Colombian cassavas imported from Jamaica; in connexion with this, trials in the next year showed that native varieties were better suited to Montserrat than the Colombian kinds. Returning to 1904-5, trials with tanias, eddos and sweet potatos showed the benefit of manuring. According to the report, experiments with broom corn were commenced during this year. Only fair results were obtained at first, though there was an improvement in 1905-6, but the Report for 1907-8 states that little interest was being taken in this crop; it should be mentioned, however, that a good report was obtained, in 1905-6, on samples sent to Canada. In the last-mentioned year fair success was obtained with ground nuts, and trials showed that the best distance for planting was one of not more than 18 inches in either direction; other experiments confirmed the fact that ground nuts are not suited to stiff clayey soils. In 1906-7 tanias of various kinds were being grown for distribution, and at the same time an experiment with the yam bean showed that the best results were obtained from staking. The trials with ground nuts in 1907-8, showed that, under the conditions, Tennessee Red gave better results than Dixie Giant. The native cassavas, in this year and in 1908-9, were still showing themselves superior to the Colombian, and both kinds were being raised for distribution. During this period, a plot of maize was planted for the purpose of commencing seed selection experiments, and various beans and peas continued to be grown at the stations for distribution and to encourage their cultivation in the island. In 1909-10, selection experiments with ground nuts were commenced, and in regard to varieties the Gambia was found, so far, to suit Montserrat best; another result obtained was the indication that liming was good for ground nuts, under the conditions. During this period, the corn selection experiments were recommenced, as planting material from the previous year failed to be produced. By this time, through the work of the past years, a fairly good collection of yams has been got together, and particulars of the quality of the various kinds are given in the report for the period. It should be mentioned, lastly, that, in the early reports, details of the expenditure entailed in the growing of various crops are given; also that throughout the time under review large quanties of good varieties of sweet potatos have been raised regularly for distribution.

MISCELLANEOUS CROPS AND SUBJECTS.

The chief matters to which reference has not been made under the above headings are, with the times at which they were given attention, as follows: agricultural shows, 1900-1, 1903-4, 1904-5; Arbor Day, 1903-4 and 1904-5; arrowroot, 1900-1 to 1904-5, and 1906-7; bananas, 1907-8 and 1908-9; bay trees and bay oil, 1903-4 to 1909-10; bee-keeping, 1900-1 to 1904-5, and 1906-7 and 1908-9; Ben oil, 1909-10; Bermuda lilies, 1902-3; cacao, 1904-5 to 1909-10; capsicums, 1901-2 to 1903-4, and 1906-7 and 1907-8; coffee, 1901-2 and 1903-4 to 1905-6; eschalots, 1902-3, 1903-4 and 1905-6; Exhibition, Liverpool Products, 1906-7; Exhibitions, Canadian, 1907-8 and 1908-9; experiment stations, description of, 1900-1 and 1906-7; fibre machinery, 1908-9; fungi and fungicides, 1908-9 and 1909-10; ginger, 1900-1 to 1906-7; grapes, 1904-5; grape fruit, 1902-3; hedges, 1903-4 to 1905-6 and 1908-9; hurricane relief, 1900-1; insects and insecticides, 1906-7, 1908-9 and 1909-10; lectures to teachers, 1901 to 1902-3 and 1905-6; liquorice, 1907-8; millions (mosquito-destroying fish), 1906-7; oranges, 1901-2, 1902-3, 1905-6, 1906-7, 1908-9 and 1909-10; *Pilocarpus racemosus*, 1907-8 and 1908-9; pine-apples, 1901 and 1902-3 to 1907-8; plant fumigation, 1909-10; poultry, 1902-3 and 1903-4; red sorrel (*Hibiscus Sabdariffa*), 1907-8; rubber, Castilloa, 1900-1 to 1906-7; rubber, Ceara, 1901-2, 1904-5 and 1906-7; rubber, Funtumia, 1903-4, and 1904-5; school gardens, 1901-2 to 1904-5; sisal hemp, 1903-4 to 1906-7; stock, 1902-3 to 1909-10; tobacco, 1900-1; transplanting of trees, 1909-10.

Experiments with pine-apples in 1902-3 gave success with applications of kainit and basic slag. In 1904-5, the Black Antigua variety was reported as doing well in Montserrat. By 1905-6 a collection of useful kinds of pine-apples was in the possession of the Agricultural Department. In the next year experiments were being conducted with reference to the prevention of the black heart disease; there were no shipments of pine-apples during this year, on account of the want of regular communication with England, and cotton was being planted in the pine-apple growing districts. A last matter of importance recorded concerning pine-apples is that an experiment in 1907-8, in which shading was tried, showed that this caused no difference in growth, or in the period of ripening. In regard to rubber, Funtumia is recorded in 1903-4, as showing a tendency to assume a bush form in light soil, and the tree form in heavy soil; in 1904-5 it was found to be growing best without shade. The Report for 1903-4 states that trees of Castilloa planted in 1900 had made good growth, and that some were bearing fruit. The plants developed successfully in 1904-5, and by 1905-6 several of them had produced seed which was used for distribution; this production of seed is reported as being again employed for raising plants, in 1906-7. As regards Ceara rubber, trees that had been planted at the Grove Station varied in development—by 1904-5 some had made vigorous growth, while others were dying. The Report for 1906-7 states that these trees were stunted, and attempts to obtain latex gave poor results, so that they were dug up.

In 1903-4, the annual export of bay oil from the island was stated to be between 50 and 60 gallons. Trees had been put in at Harris's Station in 1902-3 for the purpose of testing the effects of constant topping, and during these years, plants were being obtained in the island from the forest, for planting out. It was reported in 1905-6 that the bush form of growth was found satisfactory; the trimmings from $\frac{1}{22}$-acre gave 121 lb. of leaves; the yield in the next year from the same area was 176 lb.; at this time a distribution of plants by the Agricultural Department is reported as being made. In 1908-9, the bay tree cultivation under the Department was extended and the reaping experiments were continued, with results similar to those of former years. By 1909-10, plants put out in the preceding year had averaged about 4½ feet in height. Experiments with sisal hemp in 1904-5 gave a yield of leaves estimated at 20,212 lb. per acre, with a cost of cultivation, etc., amounting to £4 17s., while about £9 could have been obtained from catch crops of onions and corn, grown between the rows as long as the size of the sisal plants permitted this to be done. The continuation of the experiments, in 1905-6, showed that the yield of fibre per acre was about 12 cwt. Finally, it is recorded in 1906-7 that sisal plants raised at Grove Station were ready for reaping in two years instead of in three or four, while the plants poled earlier than is normal and the yield of leaves was comparatively high.

ANTIGUA.

Staff.

In 1899, Mr. W. N. Sands, a member of the gardening staff of the Royal Botanic Gardens, Kew, was appointed to the post of Curator. This officer was granted leave from April to August 1903, during which time his duties were performed by Mr. A. H. Kirby, B.A., Agricultural and Science Master at the Antigua Grammar School, under the Imperial Department of Agriculture. In January 1904, Mr. Sands was appointed Agricultural Superintendent in St. Vincent, and Mr. Kirby again discharged his duties, until the arrival from England on April 13, 1904, of Mr. W. H. Patterson who had been appointed Curator to succeed Mr. Sands.

Another change took place in the next year, for on January 25, 1905, Mr. Patterson was appointed to the post of Resident Master at the Agricultural School, St. Vincent. His place was taken by Mr. A. J. Jordan, Curator of the Montserrat Botanic Station, who arrived in Antigua on January 28, 1905. The post was held by Mr. Jordan until August 17, 1905, after which date he left Antigua to take up an appointment under the Trinidad Botanical Department, while on the last-mentioned date he was succeeded by Mr. T. Jackson, from the gardening staff at Kew, who holds the post at the present time.

A cadet system was introduced into the working of the Botanic Station, when it first came under the administration of the Department, the cadets being boys of respectable parents; these did the lighter work in the garden, and were in receipt of a small sum of pocket money weekly. The intention was that the youths should receive a horticultural training of sufficient scope to enable them, later, to take up positions of minor responsibility in the Botanic and Experiment Stations. Difficulties in carrying out the scheme were encountered from the first, although in later years its results have been more useful. In 1907, it was revised in regard to certain details, and those working under it were no longer designated as 'cadets', but as 'gardening pupils'. This change was made on account of a new departure that took place during the year, by which boys at the Grammar School who had been agricultural scholars, and were leaving school, were allowed to enter the Botanic Station and the Government Laboratory as Cadets, for a year with possible extension, under an entirely new plan, on condition that they continued to attend the agricultural science classes at the Grammar School. The new departure has met with success, and is showing itself useful for the provision of overseers on estates, as well as for that of assistants in the field experiments of the Department in Antigua.

ORNAMENTAL AND USEFUL PLANTS OF STRIKING SPECIES AT THE STATION.

As is the case in the other islands, the Botanic Station in Antigua is partly reserved for the growing of demonstration specimens of ornamental plants, and of those of economic value. New species of these are introduced from time to time and those which grow successfully are made the subjects of observation from year to year, particularly in relation to the flowering and fruiting periods, and to the elucidation of useful facts regarding the behaviour of the plants in their new surroundings; so that these will be available for use in the event of its being desired to enter upon the cultivation of any of the plants, on an economic scale.

ECONOMIC EXPERIMENTS.

In June 1900, a small piece of land was set aside at the Botanic Station for the purpose of demonstrating the way in which peasants' gardens could be made useful to the community and remunerative to the individual. This was cultivated in a way that could be employed by a peasant, and was used for raising such crops as might be consumed by such a cultivator, or could be easily disposed of, locally. It is stated in the Report for 1901-2: 'the object of the experiment was to learn what could be grown by a peasant on a small plot of land such as he might have surrounding his house; what labour would be required; and what the value of his produce would be.' The area of the land in 1900-1 was $\frac{1}{10}$-acre; in 1901-2 it was increased to $\frac{1}{7}$-acre. Details of the expenditure and receipts for the different years are as follows:—

Year.	Expenditure.			Receipts.		
	£	s.	d.	£	s.	d.
1900-1	1	15	3	2	15	0
1901-2	3	11	0	4	13	5
1902-3	2	5	7	4	5	3
1903-4	1	0	1	1	9	6

In 1904-5 and 1905-6, the dry weather that was experienced caused the returns from the peasant's garden to be very small; and after the latter period, the demonstration was discontinued and the land employed for other purposes.

EXPERIMENTS WITH STAPLE CROPS.

SUGAR. Manurial and variety experiments with sugar-cane have been conducted in Antigua (in correlation with a similar series in St. Kitts) since 1891; in 1899, these came under the direction of the Imperial Department of Agriculture, when the trials with seedling sugar-cane varieties were conducted at seven stations, and the manurial experiments at the same number. At the present time, as far as Antigua is concerned, the numbers of stations are as follows: for varieties, ten; for manurial experiments, three, as at first. It may be explained that the increase in the number of stations at which variety trials are conducted is due to the desire to obtain results with these under conditions representing as adequately as possible those obtaining on the estates in the different parts of the island, among which the circumstances of soil character and rainfall vary sufficiently to influence the behaviour of varieties according to the districts in which they are grown. For manurial experiments there is no need for such a large number of stations, as it is comparatively easy, in Antigua, to cover the broad differences in soil conditions by employing only three or four of these. Some idea of the way in which the scope of the work in connexion with seedling canes has increased may be obtained when it is considered that, while the number of these under experiment in 1899-1900 was thirteen, namely, White Transparent, Naga B., Caledonian Queen, Rappoe, Mont Blanc, B. 109, B. 147, D. 95, D. 102, D. 115, D. 116, Queensland Creole (Purple Transparent), and Burke, in 1909-10 this had increased to sixty-two in consequence of the enlarged number of such canes* that are now available for experimentation. The enhanced number of varieties has led to another difference in the present conditions of the investigation; for in 1908-9 it was decided to plant each variety in a single plot at the stations, instead of in duplicate, in order that accomodation may be obtained for the additional varieties that came in, under the circumstances detailed already.

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* See Pamphlet 67, *Seedling and other Canes in the Leeward Islands*, pp. 6-16, where a descriptive list of the varieties is given.

What has just been said serves to indicate, in a very general way, the manner in which the work of investigation with seedling varieties of sugar-cane has grown in Antigua. The progress with manurial experiments has been none the less striking. These had been carried on, together with the trials with varieties, at the Skerretts' Experiment Station, since 1891; the first report of them, issued by the Imperial Department of Agriculture, had reference to the results obtained in 1899-1900. During the year or two previous to this, the usefulness of the work had been greatly diminished owing to the virulence of the attacks of disease, which were occurring in a strongly epidemic form at that time. Returning to the commencement of the period when the work came under the administration of this Department, consultation of the records shows that the occurrence of a severe drought at the beginning of 1899 caused the experiments to be confined to a small series of trials with nitrogen as nitrate of soda and as sulphate of ammonia, in the case of plant canes that had already received a fair application of pen manure. The investigation was continued on the same lines during the next season (1900-1), with the addition that ratoon canes were now available for observation as to the effect of the manurial treatment just mentioned, while the scope of the experiments with plant canes was largely increased. The nature of this increase is best demonstrated by reference to the *Report on Sugar-Cane Experiments in the Leeward Islands*, 1900-1. Part II, pp. 22 and 23, where it is shown that the trials were now made with the following: pen manure alone (No. 2); nitrogen (with potash and phosphate) as nitrate of soda and sulphate of ammonia, in one and two applications, and as dried blood in one application (Nos. 3-12); nitrogen (with potash only) as sulphate of ammonia in two applications (No. 13); nitrogen (without potash and phosphate) as nitrate of soda and sulphate of ammonia in one and two applications (Nos. 14-17); phosphate alone, and phosphate (with nitrogen and potash), as basic slag in different quantities (Nos. 19-25); potash alone, and potash (with nitrogen and phosphate) as sulphate of potash in different quantities (Nos. 27-30); nitrogen and potash without phosphate (No. 18); nitrogen and phosphate without potash (No. 26); and guano in different quantities and in one and two applications (Nos. 31-33). The whole series was controlled by the use of no manure plots (No. 1). It should be stated that the numbers included here in brackets relate to the different kinds of manurial treatment; they are given, in accordance with the above references, in the *Report on Sugar-Cane Experiments in the Leeward Islands*, 1901-2, pp. 1 and 2, for in this season the same experiments were continued, with the addition of trials with lime (with nitrogen, potash and phosphate) in different quantities (Nos. 35 and 36), and with nitrogen, potash and phosphate, without lime, in the same series (No. 34). The experiments were continued according to this scheme until 1904-5, when the trials with lime (Nos. 34, 35 and 36) were abandoned.

By the time that the commencement of the season 1905-6 was reached, the experiments with plant canes had been continued for six consecutive years, and each variant of the series had been repeated fifty-eight times during this period. The fact of the repetition of the trials to this extent, and the circumstance that results appeared to be sufficiently consistent, led to the conclusion that there was no need for the continuation of such work with plant canes, any longer; so that in the season mentioned (1905-6), the manurial experiments with plant canes ceased to be carried out. A summary of the work is given in the Report for 1905-6, Part II, p. 7, in which it is shown that the use of artificial manures for plant canes, in Antigua, is unremunerative and that there is no need to modify the local practices of manuring, including the use of pen manure, by the employment of additional manures for plant canes. As far as ratoon canes were concerned, however, it was deemed advisable that the experiments with these should be continued, as the use of artificial manures had proved remunerative in connexion with them, and more knowledge in relation to their employment was required. An extension of their scope was also decided upon, in order to determine the effect of the manures, on ratoons, that the system had received for production at the stage of plant canes. It was thus brought about that, in 1904-5, there were two schemes of experimentation with ratoon canes, as described above, which were known respectively as the Old Series and the New Series. As in the case of plants and of ratoons, under the old system, the manurial treatment in the New Series was conducted according to the ordinary scheme, described above, except that, as has been indicated, the plant canes which preceded the ratoons did not receive any additional manure. The experiments in the New Series were first carried out at two stations—one in Antigua and one in St. Kitts (Report for 1904-5, Part II, p. 41); in the second year (1905-6), the number of stations was increased to five, in Antigua. These trials have been conducted up to the present time.

The experiments with ratoons, in the Old Series where the original plant canes had received artificial manure were discontinued after 1906-7. Reference to the Report of that year, Part II, pp. 9-13, where the results obtained during the whole of the time of the trials (seven years) are summarized, will show that each variant in the scheme had been tested thirty-seven times, and that the figures obtained from the experiments had been sufficiently concordant for definite conclusions to be drawn from them, as to the manurial pactice that is to be recommended, in the Leeward Islands, for ratoon canes following plants that have received artificial manure.

It must not be concluded that the description given of the work with varieties of sugar-cane and of the investigations into the manurial requirements of the cane, indicates the full extent of the labours of those who have been engaged in them. It is necessary that many other matters of collateral significance shall receive much careful attention and entail a large amount of observation; among such matters are the analysis of soils, the making and employment of meteorological records; as well as the devising and adoption of improved methods in the laboratory of the increase of the accuracy of results and the facilitation of the routine work in connexion with analysis. This is, however, no means all that has to be considered in the present connexion. During the progress, from year to year, of work of the kind that is described, problems other than those of which the elucidation is being attempted particularly will be suggested, and as these often bear an important relationship to the matters that are influencing the results that will be finally obtained, they can rarely be ignored, but must receive attention in their proper places, as subjects of collateral interest. It will be well, at the present stage, to indicate the nature of the chief lines of investigation that have been followed in this way.

In the first case, attention began to be given in 1900-1 to the improvement of sugar-cane by chemical selection. An appendix to the Report, Part I, for that period, draws attention to the work of Edson, Kobus and Bovell, in this connexion (*Kew Bulletin*, 1894, p. 86; 1897, p. 317; 1899, p. 45), and gives consideration to the difficulty of determining the richness of the juice of a given cane, owing to the varying ripeness of the joints of which it is composed. The opinion is expressed that this difficulty might be resolved to a great extent by giving attention only to the juice from the lowest joints of the cane—a method that had been followed by Bovell. This investigator, however, had not appeared to choose the joints to be examined according to any definite scheme, as he did not cut the canes at any particular place in relation to the lowest point of the stem of the plants, nor was it evident if he excluded short canes from his determinations. It was therefore suggested that no cane having less than ten joints should be used for providing material for analysis, and that the portion to be examined should be that extending from the base to the middle of the fifth internode. In the work undertaken in Antigua, and described in the appendix just mentioned, 200 canes were examined in the way indicated and the tops taken from twenty of the canes—ten of those having the richest, and ten of those having the poorest, juice. From each of the tops, three plants were obtained, giving eventually thirty 'high' and thirty 'low' canes. The process was repeated with the material from the 'high' and 'low' canes, respectively, the hypothesis being that if the juice yielded by a cane forms any indication of that which will be obtained from canes raised from it, the divergence in the character of the high and low series, in regard to the richness of the juice should increase as the experiment was continued. The trials were conducted from 1900-1 to 1903-4, when a varying divergence of the kind described was found to be taking place, until, in 1904-5, the experiments were lost through drought.

In regard to a line of work that was adopted on account of its close connexion with the main interest of the investigations, reference may be made to the production of seedling canes in Antigua. No success was obtained in the attempts to effect this, for several years, until in 1901 three seedlings were obtained, followed in 1902 by the raising of some 350 plants; these were planted out in May 1903. The first selection was made from the produce of these seedlings in 1909-10, and the cane variety raised in Antigua has now definitely entered into experimental competition with the others that are under trial in the Leeward Islands; though it is too early to arrive at any conclusions as to the character of the material forthcoming from it. (See Pamphlet No. 67, *Seedling and other Canes in the Leeward Islands*, p. 73, which deals with the results detailed in the Report for 1909-10, Part I.)

A third matter of collateral interest, in relation to seedling canes, receives attention in an appendix to Part I of the Report for 1904-5. This describes the results of work undertaken for the purpose of ascertaining if any of the varieties, which numbered thirty-five at that time, showed an abnormally high quotient of purity for the juice. The question arose out of work that had been done in connexion with the abnormally high purity shown by the juice of some canes, and which is described in the *International Sugar Journal*, Vol. II, p. 145. It is sufficient to state here that the work in Antigua showed that, of the canes examined, six gave evidence of the possession of abnormally high apparent purities; these were Red Ribbon, Queensland Creole, D. 74, D. 89, D. 99 and D. 119.

The parts of the reports dealing with seedling canes, for the years 1902-3, 1903-4 and 1906-7, contain appendixes which describe experiments in treating cane cuttings with various fungicides before planting them. In the first two of these periods, the trials comprised treating tops and cuttings with Bordeaux mixture for two hours, tarring the ends, or treating with Bordeaux mixture as before and tarring the ends as well, the planting material being placed in the ground vertically. In the trials of 1902-3, the planting was done with the ends covered or with the ends not covered, or horizontally; in 1903-4, all the canes were planted in a manner similar to that in vogue in the Leeward Islands, namely nearly vertically, with the ends covered. A control with untreated cane was provided in all cases. The results of the two seasons' experiments were to show that more plants are to be expected from tops than from cuttings; that Bordeaux mixture is by far the most effective protective agent, that was used for the cane, and this fact applied more to the case of cuttings than tops; that though there was some benefit from tarring the ends, this was not by any means as great as that from the use of Bordeaux mixture; and lastly, that using Bordeaux mixture and tarring the ends as well did not give as good results as the employment of the Bordeaux mixture alone. As has been indicated, the effect of different ways of planting was only tried in the first of the seasons mentioned, when it was found that vertical planting, with the ends covered, produced the best results. In the experiment of 1906-7, treatment with Bordeaux mixture alone was employed, with the proper controls; and in this case the investigation was undertaken with a rather different purpose, namely to ascertain if cane-planting material gave a larger number of sprouts when it had been treated with this fungicide, under the conditions obtaining during a very dry period. The material was treated with the Bordeaux mixture for four different lengths of time, ranging from ten minutes to twenty-four hours, the intermediate times being two and twelve hours, and observations extending over seven weeks showed that, in the case of cane tops, the soaking in the mixture was beneficial except where this had only been done for ten minutes, and that though a similar beneficial effect was found in the case of cuttings, this was less marked. In one instance, the observations were made with whole canes, planted in short lengths and were continued over a longer period than seven weeks, when it was shown by an examination of some of the unsprouted canes that the preserving effect of the Bordeaux mixture was still being exerted, and later, support was given to this conclusion by the receipt of rain, which caused the sprouting of most of the cuttings. It is thus seen that, although the results of the experiment are of interest, the investigation cannot be regarded as complete.

This suffices for a short indication of the lines of collateral investigation that have been taken up from time to time in connexion with the experiments with seedling canes. It only remains to make reference to one or two additional matters in relation to the same interest. The first of these is the conduct of an enquiry into the incidence of sugar-cane diseases in Antigua, which is described in an appendix on page 71 of the Report for 1905-6; this was undertaken through the medium of a circular letter to planters in Antigua, asking several questions about the extent to which cane diseases existed, and the degree of attack of plants and ratoons, and of different varieties. In the result it appeared that, while planters were of the opinion that there was no serious amount of sugar-cane disease at the time—possibly less than in the past few years—nevertheless the position must be watched constantly; and the opinion is given by Dr. Watts that this is probably an understatement of the extent to which disease is existent, particularly in relation to Marasmius. The other matters have to do with the inclusion of new features, in the reports on experiments with seedling canes, namely, information concerning the area planted in the newer varieties, since that of 1906-7; and the presentation of a summary of the average yields from canes at the experiment stations for the past few years, commenced in the Report for 1908-9, Part I.

The account of investigations that have been conducted alongside the main experiments for which the work was planned would not be complete without reference to those accompanying the manurial trials. The most important of such matters was an enquiry, in 1902-3, into the relation between the tonnage of canes and the amount of sucrose in the juice, per acre. In the Report for that season, Part II, the details are given of an enquiry into this relation, by which it is shown that under the manurial practice in the Leeward Islands, the tonnage of canes, per acre, and the sucrose in the juice, per acre, bear a constant relation to one another. The importance of this fact was quickly recognized, and from the next season (1903-4), the comparisons of yields under the different manurial treatments have been made on the basis of weight of canes instead of pounds of sucrose in juice; so that a large amount of the tedious work of crushing of canes and analysis of juice has been avoided, while dependable results have been obtained in a speedy and simple manner.

The existence of estates in Antigua possessing heavy clay soils has drawn attention to methods which may be adopted for the purpose of making these soils more suited for the growing of sugar-cane, and the presence of plentiful supplies of marl in parts of the island has led to the suggestion that this may well be employed in the special connexion. Definite experiments were carried out on one of the estates (Bendals), in 1903-4 and 1904-5 (see Reports for these seasons, p. 11 and p. 52). The results show that the application of marl containing 58·8 per cent. of calcium carbonate, at the rate of 40 tons per acre, increased the yield of canes both in the case of plants and of the ratoons that came after them, while there was a visible improvement in the condition of the soil. It was further demonstrated that, where tramway haulage is available, and where the marl can be brought by gravity from a neighbouring quarry, the cost per acre of marling, in Antigua, need not exceed £4.

Another series of experiments was suggested by the circumstance that the application of phosphates, as manure for plant canes, did not appear to result in remunerative yields, under the conditions existing in the Leeward Islands. As these experiments were carried out in St. Kitts, they will be described shortly when the account of botanic station and experiment station work in that island is being given; the details are to be found in Part II of the Reports for 1902-3, 1903-4 and 1904-5, pp. 52, 45 and 5, respectively.

The constant demonstration by the results of the experiments that the application of pen manure forms the most important and useful means of increasing the yields of sugar-cane in the Leeward Islands has naturally directed much attention to this and allied manures, particularly in regard to their composition and manner of application. Through this circumstance, interesting results arising from the analysis of such manures have been made available for the use of planters; these are to be found on page 52 of the Report for 1905-6.

A final matter in connexion with collateral experiments in relation to the manurial treatment of sugar-cane, is that attention has been given in more recent years to the cultivation of ratoon canes (Reports, 1907 8, p. 9; 1908-9, p. 20; and in that for 1909-10), the application of molasses to sugar-cane soils (Report, 1908-9, p. 20; and in that for 1909-10), the use of calcuim cyanamide and nitrate of lime, for sugar-cane growing (Report, 1909-10), and the effect of small applications of lime on the action of artificial manures (Report, 1909-10). These more recent experiments have not been conducted sufficiently long for definite results to be stated; they should prove of much use when these are eventually available.

COTTON. Experiments in connexion with the revival of cotton-growing in Antigua were commenced in 1901-2 and 1902-3; in the latter season trials of six varieties were made, including those of Sea Island as first growth and as second spring (or ratoons, as it is sometimes called mistakenly); no definite results were obtained. In the next year, there were no experiments; the severity of the insect attacks, particularly of the cotton worm (*Alabama argillacea*), made it necessary for the work to be directed toward giving assistance throughout the island to those who had planted cotton, in order to enable them to cope with these, as far as possible. The season 1904-5 saw the first experiments in crossing cotton, the crosses being Rivers (a Sea Island type that had undergone long and careful selection in the Sea Islands) and native Antigua, and Rivers by Nevis Purple Leaf, both ways; this was an attempt to obtain a Sea Island hybrid possessing the hardy qualities of the wild native cotton, but no definite results for the season were obtained. Other work was concerned with experiments to determine the cause of the lack of the uniformity in the distribution of the fuzz on Rivers seed, and it was found by grading the seed according to this character, planting the different kinds, and then grading again, that typical Rivers seed possesses a slight amount of fuzz at both ends; there was also the conclusion that both absolutely clean seed and fuzzy seed tend to produce seed of the typical Rivers' kind. (See Antigua Annual Report for 1904-5, and *Agricultural News*, Vol. IV, p. 106.) In the next season, namely, 1905-6, variety tests were made with St. Vincent, Gilberts and Centreville cotton, when the best results were obtained with the last-named kind, although the staple of the cotton produced was irregular. The matter of note is that cotton selection experiments with Sea Island were commenced on definite lines during this period.

The increased importance of the cotton industry, and the careful work that was required in view of the untoward conditions that surrounded that industry, have caused the scope of the investigations to be largely increased during succeeding years; this is described as shortly as possible in what follows. The season 1906-7 showed that the attempts, made in 1904-5 to obtain hardy, yet valuable hybrids of Sea Island cotton by crossing with Antigua and Nevis native kinds, were a failure, on account of the large amount of weak fibre given by the plants grown from the seed that had been obtained from crossing; particulars of the results that were forthcoming are given in tables on pages 42-44 of the Antigua Annual Report for 1906-7. Further work was concerned with trials in regard to the keeping qualities of selected and disinfected seed, experiments in distances of planting, and a comparison of the success obtained with Rivers and Gilberts seed from different parts of the island, the results in connexion with the last two being to indicate, respectively, that close planting decreases the yield of cotton, and that no advantage was shown in regard to planting a given estate with seed from other cotton-growing centres in the island. This work, though very necessary and expedient, is overshadowed in importance by that of the cotton selection investigations, which were continued, in a greatly extended form, from the previous season, following the scheme presented in the *West Indian Bulletin*, Vol. VII, p. 153. A detailed account of these experiments is contained in the *West Indian Bulletin*, Vol. IX, p. 220; it is sufficient to state here that they showed that the effects of selection in improvement are marked, and that they gave proof of the wisdom of conducting selection experiments for the purpose of providing suitable strains for individual districts. During 1907-8, the different lines of work were followed in much the same way, when varying results were obtained in regard to selection, probably owing to the character of the weather experienced during the season; these, however, continued to show that success is almost certain to follow properly devised selection (see *West Indian Bulletin*, Vol. IX., p. 224); the distribution of selected seed to planters was enlarged, and this feature of the work in connexion with selection is still continued. Further trials with Centreville cotton indicated the inferiority of this kind to Rivers and Gilberts. The evidence that was constantly obtained to the effect that clean, black seeds bear the least desirable type of lint caused trials to be made in order to ascertain if this character was produced constantly, on the sowing of such seeds, and the necessity was shown for the elimination of seed of this type, for planting purposes. Other work included experiments in regard to the best distance for planting cotton which gave similar results to those of the previous year and the commencement of trials with Caravonica cotton at Scott's Hill. As regards the two succeeding seasons, 1908-9 and 1909-10, reselection from selected cottons continued to give increased yields; an account of the enhanced work undertaken during these years may be given as follows.

In 1908-9, trials made with Centreville and Stirling cotton—the latter a strain of Sea Island raised at Stirling Plantation, Barbados—gave very poor results for the former, while these were only fair for the latter; continued experiments in distances for planting ordinary Sea Island were not conclusive. The Caravonica cotton sown in the previous season grew well, but gave a very poor yield and was severely attacked by insect pests. During this period, several new lines of experimentation were commenced. In one of these, cotton seed was sown in ordinary soil and in soil treated eight days previously with carbon bisulphide, as well as in soil over which trash mixed with soil had been burned; largely increased yields were obtained with the carbon bisulphide, but with the burning the yield was decreased. Experiments were commenced, on an estate just outside of St. John's in regard to the treatment of soil with artificial manures for the control of the flower-bud maggot, and these were supplemented by an investigation at the Station to find if the flower-bud maggot of cotton is identical with that of the privet or wild coffee (*Clerodendron aculeatum*). The next season, 1909-10, saw the continuation of much of this work, when no definite results were obtained in regard to manurial treatment for the control of the flower-bud maggot, and the cross-infection experiments with this insect, in regard to cotton and privet, were abandoned because of its absence, where observations were made, from the buds of the latter plant. The similar small incidence of this pest on cotton also prevented any results from being obtained in trials where the soil was treated with Vaporite, in the hope of reducing its numbers while it was in the pupal stage. Observations on the time of appearance of the flower-bud maggot, in this season and the last, showed that this took place in October, indicating uniformity of behaviour from year to year in this respect, and suggested the early planting of cotton for the purpose of reduce ing the damage done by it; the usefulness of the adoption of this course was unmistakably indicated in experiments in which cotton was planted early and late, and a comparison made of the different yields. Cross-infection experiments with the leaf-blister mite of Acacia did not show that this pest attacks cotton. The trials with carbon bisulphide in soil for growing cotton were not as conclusive as those of the previous year. Hybridization experiments with cotton were recommenced during this period, the following crosses being made: Sea Island × Southern Cross, Sea Island × Nevis Purple Leaf and Southern Cross × Antigua Native; the crosses were made six times: three times with Sea Island as male parent and three times with this variety as female parent. It has been indicated already that success continued to be obtained in cotton re-selection experiments; in this connexion and as regards the distribution of selected seed to estates, the following quotation from the Annual Report for 1909-10 is of special significance: 'The majority of the seeds planted during the year was from selections made either at the experiment stations or at estates, and it is worthy of note that the estates which did exceptionally well were planted with seeds selected in the field and Laboratory by officers of the Agricultural Department.'

A final matter for mention—and one that is not described in the Annual Reports of the Botanic and Experiment Stations—is the carrying out of manurial experiments with cotton in Antigua (and St. Kitts and Montserrat) since 1904, according to a plan published in the *Agricultural News*, Vol. III, p. 237. The results obtained in these, so far, have been published in the *West Indian Bulletin*, Vols. VI, p. 247; VII, p. 283; X, p. 269; XI, p. 60. They indicate that, in the Leeward Islands, soils in moderately good tilth do not require either natural or artificial manures for cotton production; though of course the employment of natural manures and the growing of green dressings are required from time to time, in order that the condition of the soil may be maintained.

EXPERIMENTS WITH MINOR INDUSTRY CROPS.

ONIONS. The work in relation to this crop, which is grown chiefly as a catch crop with sugar-cane, has consisted rather of efforts to encourage the extension of the industry by such methods as the giving of advice in connexion with its cultivation and marketing, and the importation of seed by the Department for the use of growers, to whom it is sold at cost price; in the latter regard, since 1900-1, quantities of seed amounting from 30 to over 300 ℔. and totalling more than 1,700 ℔. have been obtained from Teneriffe and distributed to planters in the Colony; young nursery plants have also been sent out from time to time. In 1903-4, a trial of the red and white varieties of the Bermuda onion was made: the results obtained were inconclusive, but gave a slight indication in favour of the white variety. A similar trial conducted in the next season gave a more definite result in favour of the red, though repetition in 1905-6 afforded no information, on account of the poor results obtained through drought. A manurial trial was conducted in 1906-7, when the yields were in favour of manuring. In 1907-8, a small demonstration plot of onions was planted at one of the experiment stations. Finally, the position that this minor crop has taken in Antigua may be judged from the following quotation from the Annual Report for 1909-10, p. 11 : 'It would appear safe to say that the growing of this crop is firmly established in Antigua, and if no unforeseen circumstances arise, an increased area can be looked for in the future.'

PINE-APPLES, LIMES AND COCOA-NUTS. The conditions at the Botanic and Experiment Stations do not permit of the successful growing of pine-apples, so that little has been done in the way of experimentation, since 1900-1, when trials of varieties and with methods of packing were made, and 1901-2, when the trials were continued, and investigations in relation to disease were made, except in 1904-5 when there was an unsuccessful attempt to grow plants at the station for the purpose of making observations on the pine-apple diseases ; the work in connexion with this crop has consisted chiefly in giving advice as to its cultivation, though the amount of such work has decreased materially since the decline of the export industry. The position is much more encouraging in regard to lime-growing, as an increasing demand for plants testifies that the industry of lime production is increasing in extent, in Antigua ; evidence of the greater demand is furnished by the records at the Botanic Station which show that, out of nearly 35,000 lime plants distributed during the ten years 1900-1 to 1909-10, more than 23,000, or about two-thirds, have been sent out within the last three years, 1907-8 to 1909-10. The only other minor industry that has received an increased amount of attention during recent years is the production of cocoa-nuts. The amount of land available in Antigua for this is not great, so that the output will be restricted at the best of times. There is a healthy interest, however, in attempts that are being made to extend the growing of the cocoa-nut palm, as is evidenced by the increased distribution of plants from the Botanic Station—1907-8 214, 1908-9 1,975, 1909-10 1,860.

EXPERIMENTS WITH MINOR CROPS.

PROVISION CROPS. The trials with minor provision crops (besides those in the peasant garden) have been made with the following kinds, and during the seasons indicated in the table, in which the times of experiment with any given crop are indicated :—

	1900-1.	1901-2.	1902-3.	1903-4.	1904-5.	1905-6.	1906-7.	1907-8.	1908-9.	1909-10.
Sweet potatos	+	+	+	+	+	+	+	+	+	+
Yams	+	+	+	+	+	+	+	+	+	+
Eddos and tanias	+	+	+	+	+	+	+		+	+
Cassava	+	+	+	+		+	+	+	+	+
Ground nuts	+							+	+	+
Bush Lima beans				+		+				
Pole Lima beans						+				
Red cowpea*					+	+				
Natal peppers					+					
White pigeon pea						+				
Cowpeas, different varieties							+	+	+	+†
Tomatos							+			

* Determined, in 1906-7, to be a mixture of different varieties.
† Red variety, only.

The results for sweet potatos and yams, for the ten years 1900-1 to 1909-10, are summarized in the Annual Report for 1909-10, and attention may be drawn to the tables that are given in this. The experiments with cassava, commenced in 1902-3 and conducted because of the realization of the want in Antigua of a crop of this kind, were extended to include trials with sweet and bitter creole varieties, and with Colombian varieties, of which the last were found to maintain their characteristic property of being remarkably free from hydrocyanic acid, when grown in Antigua. It was found, however, that these showed a particular susceptibility to attacks by caterpillars, and that they were inferior to varieties from Montserrat and from Jamaica (the latter of which were introduced in 1906-7) in yield, and in starch production; though they were superior as regards cooking qualities. In a general way, though greater success has been obtained in recent years, it is found that the soil of the experiment station where the varieties are grown is not suited to the remunerative raising of cassava. The investigations with ground nuts were unsuccessful, in 1900-1. Variety trials were commenced in 1907-8, and continued in the next year; in 1909-10, the Spanish variety, only, was planted. The results have been uniformly indifferent, owing apparently to the unsuitability of the soil at the experiment station to the cultivation of ground nuts. The trials with Natal peppers in 1904-5 were successful. Eddos and tanias have given fair results, but the uncertainty of the crops causes them to be grown to a moderate extent only, in Antigua. Finally, in regard to cowpeas, the Black Eye and Iron varieties gave the best yields; while the only trial with tomatos on any scale, in 1906-7, showed that the kinds planted were very susceptible to the disease caused by *Bacillus solanacearum.*

CORN AND MILLET CROPS. The extent of the important experiments with corn and millet crops is shown in the following table :—

	1900-1.	1901-2.	1902-3.	1903-4.	1904-5.	1905-6.	1906-7.	1907-8.	1908-9.	1909-10.
Indian corn	+	+	+	+		+		+	+	+
Guinea corn	+			+	+			+	+	+
Broom corn		+	+	+	+	+	+	+	+	+

In the earlier years, the experiments with Indian corn included trials with varieties from the United States. These were uniformly unsuccessful, and were replaced by attempts to effect an improvement of the native varieties by crossing them with some of the best among the former, when no better results were obtained. The native kinds had always given the best yields, so that, since 1905-6, efforts have been made to improve these by selection ; in 1909-10, however, the root disease of maize caused the results to be very poor. Useful work in connexion with selection is nevertheless being done on several of the estates, by planters. As regards Guinea corn, the earlier experiments included trials with different varieties, and it was found that Nevis corn gave the quickest return as a fodder, while it showed a good capacity for resisting drought ; the only .others that merited attention were white Guinea corn and Kafir corn. Since 1907-8, varieties from Northern Nigeria have been grown ; they possess a disadvantage in the extent to which the seed is eaten by birds. The third crop included in this section—broom corn—has received a large amount of attention at the experiment stations, since 1902-3, and there have been several attempts by the Agricultural Department to introduce the making of brooms from the corn, more especially as a home industry. In 1904-5, fairly good reports were obtained in regard to samples of the corn grown in the island and sent to Canada and the United States for examination by broom corn factories ; in the Annual Report for that year, information is given as to the demand and kinds required in the markets of these countries. The work in the seasons 1907-8, 1908-9 and 1909-10 included trials of various distances of planting ; in the first two periods, these gave yields slightly in favour of the closer planting, with the production of a finer corn than when the crop was grown at the larger distances, whereas in 1909-10, the more widely planted corn yielded the greater weight of brush. In the last-named season, experiments on a larger scale were made by planters on estates, and the plants were found to yield a high proportion of seeds to heads ; the Report for this period presents information gained in the experiment stations as to the best method of handling the crop.

GREEN DRESSING CROPS. A summary of the reported trials with green dressing crops, in Antigua, is given in the following table:—

	1900-1.	1901-2.	1902-3.	1903-4.	1904-5.	1905-6.	1906-7.	1907-8.	1908-9.	1909-10.
Cowpeas, varieties	+				+	+	+	+	+	+
Dolichos spp.	+	+								
Bengal bean	+	+								+
Horse bean	+								+	
Woolly pyrol	+				+	+	+	+	+	+
Cyamopsis sp.	+	+								
Soy bean	+	+						+		+
Velvet bean	+	+			+					
White bonavist bean Louisiana cowpea	+	+	+							
Barbuda bean								+	+	+
Bonavist bean								+		
Pigeon pea						+		+	+	
Babricou bean								+	+	
White mustard								+	+	
Sand vetch								+		
Japanese clover					+			+		
Chicory								+	+	
Java Crotalaria									+	+
Dwarf Essex rape.									+	
Thousand-headed kale									+	
Mustard									+	+
Lathyrus latifolius									+	
Castor oil plant									+	+
Lima bean				+		+				+
Broom corn										+
Ground nut										+

The results of the earlier experiments were mainly to show that the bonavist bean and woolly pyrol are useful green dressing plants for Antigua, while the soy bean and velvet bean proved uniformly unsuccessful. With reference to the last, material distributed for trial on estates, in 1900-1, gave results which showed that the velvet bean is of little value as a green dressing plant, in Antigua, owing to its susceptibility to insect attacks. During most of the time under review, there has been a steady distribution of seeds of leguminous plants, for use on estates in Antigua, as the need of such plants in the island is fully recognized, both for the food which their seeds afford and for the purpose of providing green dressings. Since 1907-8, the trials with green dressing plants have been largely extended, and useful results are now forthcoming from them. In this year, the experiments indicated that the following may be particularly recommended for employment in Antigua: Barbuda bean, woolly pyrol, bonavist bean and Babricou bean; the necessity for further trials was indicated in the case of the soy bean, while white mustard, sand vetch (tares) and Japanese clover were not recommended. The chief drawback to the use of cowpeas has been the frequency with which they have suffered from bad attacks of caterpillars; Paris green and lime, in 1907-8, even in the proportion 1:90 was found to scorch the leaves, while in the next year lead arsenate, either alone, or with lime 1:7, did little injury to them, but gave indications that it must be applied early if it is to be effective against caterpillars on cowpeas. It is a matter of some interest that, in 1908-9, most of the cowpeas tried on estates remained free from insect attacks; in the trials on the experiment plots the variety Iron gave the best results. The green dressing plants specially recommended for use in the season just mentioned were Barbuda bean, chicory (for heavy soils), sword bean, pigeon pea, Java crotalaria and woolly pyrol, though the last was found to be susceptible to attacks of red spider. Java crotalaria yielded more green dressing material than the pigeon pea, for which it is suggested as a substitute. Bokhara clover was tried as a green dressing; on the results obtained, it is recommended for employment on estates, on a small scale, as a cattle food.

In the last period under review, 1909-10, the best yields were obtained from the Bengal bean; the susceptibility of this plant, however, to insect attacks renders some form of control necessary, and this has been provided successfully in the form of Paris green and lime in the proportion 1:10—a mixture which scorches the leaves but does not prevent new growth from being made immediately, to take their place; the best stands of the Bengal bean are obtained by sowing the seed at a time of good rains, or by planting them deeply in the soil. Among the other plants. Java crotalaria showed special immunity from insect attacks, In addition to these, the Barbuda bean continued to be recommended highly as a green dressing plant for Antigua, and the recommendation extended to woolly pyrol and pigeon peas. The results obtained by growing the castor oil plant as a green dressing were somewhat poor, being inferior to those of the previous year.

PASTURE AND FODDER CROPS. Details concerning the following appear in the different reports :—

	1900-1.	1901-2.	1902-3.	1903-4.	1904-5.	1905-6.	1906-7.	1907-8.	1908-9.	1909-10.
Alfalfa (*Medicago sativa*)		+				+				
Teosinte (*Euchlaena mexicana*) ...			+					+	+	
Mangel wurzel (*Beta vulgaris*, sp.) ..					+				+	
Guinea corn (*Andropogon Sorghum*, var. *vulgaris*.)	+			+	+			+	+	+
Refugee bean						+				
Rape (*Brassica Napus*)	+								+	
Bokhara clover					+				+	
Dwarf Essex rape									+	+
Japanese millet	+									+
Sainfoin (*Onobrychis sativa*)										+
Australian salt bush (*Atriplex nummularia*)										+
Pennisetum cenchroides								+		
Saccharum ciliare								+		

In the first experiments recorded with alfalfa (1901-2 and 1902-3), difficulty was found in establishing the plant owing to the attacks of caterpillars ; unsuccessful trials were also recorded in 1905-6, while in 1908-9, when the seed used for planting was treated with nitro-bacterine, the results indicated that alfalfa is probably best suited to the wetter portions of the island. As regards *Saccharum ciliare*, it is doubtful if this would be eaten by stock, but if this is the case, it would be a valuable fodder in Antigua ; it is suggested as an excellent wind-break for cotton fields. In 1907-8, varieties of Guinea corn from Northern Nigeria were tried ; one of these (Mazzagua) proved to be distinctly superior to that grown locally. In this and all subsequent experiments the produce obtained from the varieties was small, on account of theft of the grain by birds. Teosinte, in the three years in which it was tried, gave evidence of successful growth, provided there were no insect attacks. The experiments for 1909-10 are notable because they included trials with dwarf Essex rape, Japanese millet, sainfoin and Australian salt bush, the first of which had been grown for the first time during the previous year, when less success was obtained with the crop than in 1909-10. The Japanese millet gave a poor yield, and the general appearance of the plant was unhealthy. Sainfoin grew slowly, but remained free from disease ; while although the experiment with the Australian salt bush was of a limited character, the plant showed itself likely to be a valuable acquisition in the drier parts of the island.

OIL CROPS. The different reports contain details of crops yielding oils (both fatty and essential) as follows:—

	1900-1.	1901-2.	1902-3.	1903-4.	1994-5.	1905-6.	1906-7.	1907-8.	1908-9.	1909-10.
Castor oil (*Ricinus communis*) ..	+	+			+				+	+
Sesame (*Sesamum indicum*)	+	+							+	+
Lemon grass					+	+	+	+	+	
Ground nut (*Arachis hypogaea*) ...	+								+	
Soy bean (*Glycine hispida*)	+							+		+

Among the above crops, the castor oil plant is only grown in Antigua to a very limited extent, mainly as a green dressing. In the trials, there was no success as far as a commercial yield of the seeds was concerned in any season except 1908-9 and 1909-10. when fair results were obtained, those in the latter period being inferior to the results of 1908-9. Similar experience, as regards the return of seed, has been gained with sesame. When it was first tried, it was attacked by a fungus disease which apparently was amenable to treatment of the seed with copper sulphate solution; generally, the plants have been healthy, but as has just been stated, the disadvantage is the poor return of seed. Lemon grass, in 1904-5 to 1906-7, made good growth in spite of the dry weather, and did not show any evidence of insect attack. These conditions have obtained in subsequent seasons, including 1907-8, when plots of West Indian and Cochin lemon grass (*Cymbopogon flexuosus*) were planted; some of the material from the plots bearing these was used in 1908-9 for distillation experiments, the results of which are recorded in the *West Indian Bulletin*, Vol. IX, p. 265.

Among leguminous plants yielding oil, the ground nut was tried in 1907-8. the varieties being Dixie Giant and Tennessee Red, when the yields were poor in both cases, probably on account of the heavy soil in which the plants were grown; the foliage was attacked by caterpillars, but the insects were kept in check without damage to the leaves, by using Paris green and lime 1:6. In 1908-9, the kinds tried were Dixie Giant, Carolina Running, Spanish and Tennessee Red; the results obtained were still only fair on account of the heaviness of the soil; Carolina Running showed the best capacity to cover the ground. In the last year of trial (1909-10) the Spanish variety, only, was employed, and the results supported the opinion that the soil was too heavy for the growing of ground nuts; the attacks by caterpillars were controlled by the use of Paris green and lime 1:6, by which the leaves were scorched to some extent. Another leguminous oil seed, namely the soy bean, has proved itself capable of making growth under the conditions in Antigua, but this has always been very small, both at the Experiment Stations and on the manure. There are also the additional conclusions, namely that estates where it has been tried. It would appear that this circumstance is due to the absence from the soil of the particular strain of nitrogen-collecting bacteria which live in symbiosis with the soy bean, and the remedy has been suggested of inoculation, or of continually growing the plant on the same areas of soil with the hope that the required particular strain of the organism will be developed. Finally, as regards oil crops, it may be mentioned that cocoa-nuts have already received treatment under the heading Minor Industry Crops.

MISCELLANEOUS EXPERIMENTS AND SUBJECTS.

These have included trials with the following, which are recorded in the years shown: bee-keeping, 1900-1 to 1908-9; buckwheat, 1907-8 and 1908-9; Caravonica cotton, 1907-8 and 1908-9; distillation of lemon grass oils, 1907-8; egg plant, 1900-1; German millet, 1900-1; grape vines, 1901-2 and 1902-3; hedges, 1900-1 to 1903-4 and 1905-6 to 1909-10; insecticides (in addition to the ordinary ones) such as Scheele's green, green arsenoid, London purple, all of which are recorded in 1906-7, and Mortide Red in 1907-8; macaroni wheat, 1908-9; millions—the mosquito-destroying fish, 1905-6 and 1906-7; Natal peppers, 1904-5; poultry, 1904-5 to 1906-7; preservation of gate posts, 1909-10; Southern Cross cotton, 1808-9 and 1909-10; sunflower, 1900-1; tree-planting experiments, 1909-10; vanilla, 1900-1, 1901-2 and 1905-6. Information is also included concerning re-afforestation (1901-2 to 1908-9), and measures for the fumigation of imported plants (1909-10).

ST. KITTS-NEVIS.

STAFF.

At the time of the report for 1901-2, Mr. W. Lunt, from Kew, had been appointed as Curator, from the Trinidad Botanic Gardens, in 1898; this officer had been on leave in 1901, when his duties were performed by Wade, the foreman. At the time, the work of the sugar experiments was carried on, on various estates, under the supervision of the managers; while the field work at the central station was kindly taken care of by the Hon. E. G. Todd and Mr. W. D. Gordon, Managers of Buckleys and Con Phipps estates. Vacation leave was taken by the Curator in 1902-3, and spent in Dominica, his duties being performed by the foreman, H. Holder. Mr. Lunt died in 1903-4, and Mr. L. M. Kortright acted in his place, while Mr. F. R. Shepherd, Superinent of the Government Farm, Antigua, was placed in temporary charge of the Botanic Station and of the sugar-cane and other experiments. 1904-5, Mr. Shepherd continued to act as Curator and Superintendent of sugar cane experiments, and was subsequently confirmed in the appointment of Agricultural Superintendent, which he holds at the present time.

ORNAMENTAL AND USEFUL PLANTS.

The maintenance of the Botanic Station in St. Kitts became a charge on Imperial funds in 1898, and it is here that the chief collection of ornamental and permanent economic plants is kept.

Three years later, in 1901, experiment plots were laid out at La Guérite, for the purpose of making trials of the more temporary crops. At the station itself, the permanent collections of plants have been maintained, and additions are made from time to time as they become expedient. At the same time trials have been made with cacao and rubber on certain estates in the country. Further particulars of the Botanic and Experiment Stations in St. Kitts, in this connexion, will be found in the Report for 1906-7.

ECONOMIC EXPERIMENTS.

EXPERIMENTS WITH STAPLE CROPS.

SUGAR. The experiments are being carried out at La Guérite estate and seven other estates in the island, under the charge of the chief agricultural officer. The analysis of the juice of the canes grown for the experiments is made in a small laboratory at La Guérite by members of the staff of the Government Laboratory Antigua. In regard to seedling canes during 1899 to 1907 the total number of cuttings distributed was 182,250. As regards later years, in 1907-8, 17,000 cuttings were distributed and there were 343 variety experiment plots and 192 manurial plots, the latter as in Antigua being with ratoons alone. In 1908-9 the experiments on two of the estates were abandoned, as cotton was chiefly being grown; these were replaced by others on land kindly provided; in this year there were 340 variety experiments and 192 manurial experiments with ratoons. All these trials are being continued at the present time, and the general results are given below. This part of the account may be closed by saying that the number of cuttings of good varieties of cane distributed in 1909-10 was 14,300.

Dealing with the variety and manurial experiments in a broader way, it may be said that these are conducted on the same lines as those in Antigua, and the fact that the latter have been treated of at some length precludes the necessity for giving detailed attention here for the similar trials in St. Kitts; the general results will therefore be presented shortly. Before this is done however, it will be well to draw attention to an additional phosphate experiment with sugar-cane, carried out in St. Kitts, in 1902-3 to 1904-5. and given attention in the large sugar-cane reports for the Leeward Islands, Part II, for those years (pp. 52, 45 and 5, respectively). The experiments were laid out in duplicate on five estates as follows, all the plots having received a preliminary treatment with pen manure: (1) no manure; (2) 60℔. nitrogen as sulphate of ammonia, 60℔. potash as sulphate of potash, no phosphate; (3) 40℔. phosphate as basic phosphate, 60℔. nitrogen as sulphate of ammonia, 60℔. potash as sulphate of potash. The results in 1902-3 showed that phosphate was beneficial in one case, but it should be said that the yields from the nitrogen and potash plots were abnormally low. In the next year there was no gain from the phosphate, and in 1904-5, the addition of phosphate reduced the yield in every case. Thus the results, of these additional special experiments confirmed those of the larger, main series. As regards general results, these in St. Kitts are very similar to those of Antigua, namely that with proper tillage and applications of pen manure, plant canes do not necessarily require artifical the use of phosphates for ratoon canes is unremunerative, and that: 'nitrogenous artifical manures such as nitrate of soda and sulphate of ammonia applied to ratoon canes, are likely to give profitable increases of yield in seasons of favourable rainfall.' (See Phamphlet No. 68, *Manurial Experiments with Sugar-cane in the Leeward Islands*, 1909-10.)

COTTON. In 1903-4 cotton distance planting experiments showed the use of closer rather than wider planting. At this time an experiment was made with Sea Island cotton in Anguilla, and a large quantity of seed was distributed for planting in this island and in Nevis. At the same time applications were received for over 4,000℔. of seed, for planting during the coming season in St. Kitts, Nevis and Anguilla; this demand was in response to a circular issued by the Imperial Department of Agriculture. The encouragement of the cotton industry continued during 1904-5, and lectures were given by the Department of Agriculture, literature also being distributed by the Department including Pamphlet 31, *The A B C of Cotton Planting.* In 1905-6 fair results were obtained with trials in the experiment plots at the Botanic Station and La Guérite; in this season manurial experiments similar to those in Antigua and Montserrat, on the lines lad down in the *Agricultural News*, Vol. III, p. 327, were commenced and received subsequent report in the *West India Bulletin*, Vols. VI, p. 247; VII p. 283; X. p. 269; and XI. p. 60, as well as in the annual accounts of the botanic station work. Experiments in regard to distances and time of planting have, been steadily confirmed since, and receive an account in different reports; it may be said that the general result of the manurial experiments is the same as that for Antigua and Montserrat while other trials have been in favour of early planting, as in the case of other islands. Additional work in 1905-6 included trials with various kinds of Sea Island cotton, and reports were received from the British Cotton Growing Association on the samples produced; it is in the Report for this year that a general account of the cotton industry in the Presidency began to be presented, and the inclusion of this has continued regularly since. In 1907-8 first mention is made of definite seed selection experiments according to the scheme described in the *West India Bulletin*, Vol. VII, p. 153; this work has grown greatly in extent, and the presentation of tabulated details has been commenced in the Report for 1909-10. The following table gives in pounds the exports of cotton from the Presidency for the years 1904 to 1910:—

Island.	Year 1904.	Year 1905.	Year 1906.	Year 1907.	Year 1908.	Year 1909.	Year 1910.
St. Kitts	24,107	87,070	121.762	269,109	205,682	230,940	241,717
Nevis ...	28,449	144,721	123,044	136,670	177,427	116,998	113,722
Anguilla	1,661	31,997	81,650	59,666	76,200	56,120	36,300
Total ...	54,217	263,788	326,456	465,445	459,309	404,058	391,739

EXPERIMENTS WITH PROVISION AND OTHER CROPS.

These have been monthly carried out at the La Guérite Experiment Station. They receive particular notice in the Reports, as follows :—

	1900-1.	1901-2.	1902-3.	1903-4.	1904-5.	1905-6.	1906-7.	1907-8.	1908-9.	1909-10.
PROVISION CROPS.										
Onions		+	+	+	+	+	+	+		
English vegetables		+	+	+	+	+				
Yams..				+		+	+	+	+	+
Sweet potatos						+	+	+	+	+
Cassava						+	+	+	+	+
Pigeon peas						+				
Yam bean						+	+			
Eddos								+		+
Ground nut								+	+	+
Cowpeas								+	+	
CORN AND MILLET CROPS.										
Guinea corn							+			
Broom corn									+	+
Maize										+
GREEN DRESSING CROPS.										
Pigeon peas						+				
Velvet bean								+	+	+
Woolly pyrol								+	+	+
Cowpeas								+	+	
Crotalaria sp.									+	
PASTURE AND FODDER CROPS.										
Guinea corn							+			
OIL CROPS.										
Ground nut								+	+	+
Sesamum (*Sesame indicum*)										+

Trials made in 1905-6 with Montserrat and Colombian varieties of cassava showed that the latter were much affected by drought, and this experience was repeated in 1907-8; while in 1906-7 and 1907-8 they were attacked by red spider; in 1908-9 the trials with Colombian varieties were abandoned on account of continued discouraging results, and it was concluded that these are not suitable for growing in St. Kitts. A successful trial of the variety Black Stick, received from Anguilla, was made in 1907-8, and this gave better results than all the others in 1909-10. As regards onions, the Report for 1905-6 give details of the products from the growing of this crop, and these are again presented the next year. A trial made in the former period indicated that there was no difference in yield between the white and the red Bermuda varieties, under the conditions of the experiments. In 1907-8, trials with onions were abandoned, as it had been proved conclusively that they may be grown profitably in St. Kitts. The experiments with sweet potatos were mostly variety trials. There were others in which seedlings were sown, and at first these gained larger yields than the parent varieties, but in 1908-9 the yields from the seedlings were so poor that further trials are reported as being made in order to find out if the apparent inferiority was due to the season of planting or other cause; there is no mention of the results of this work. Trials made with ground nuts in 1907-8 did not meet with success, owing to the receipt of heavy rains at the time of the development of the fruits. In the next year, comparison was made of the varieties Dixie Giant, Spanish, Tennessee Red, Carolina Running and the local kind, when no gain was received from planting the imported varieties, on account of their being attacked by disease. Better results were abtained in 1909-10, and trials of liming for ground nuts made in this season were inconclusive. Accounts of the ground nut experiments in St. Kitts appear in the *Agricultural News*, Vol. VIII, pp. 206 and 404, and the *West Indian Bulletin*, Vol. XI, p. 161.

With reference to eddos it is observed that the variety White Nut is better suited to St. Kitts conditions than Red Nut, the latter of which has not been found to thrive well in light soils. Experiments with sesame show that there is not much chance of its being utilized as an oil crop in St. Kitts at the present time, because of the tediousness of the collection of the seed, on account of the fact that this does not all ripen together. In 1909-10 crossing experiments were made with maize, and the hybrid seed was distributed on estates, and kept at the Station for future experimentation. Lastly, in regard to green dressings, uelvet beans have been found more suitable for cultivation than woolly pyrol, owing to the susceptibility of the latter to attacks of eel worms.

MISCELLANEOUS CROPS AND SUBJECTS.

These include, with dates of their report, the following: agricultural education at the Grammar School, 1902-3 to 1909-10; agricultural shows, 1904-5 and 1906-7 to 1909-10; cacao, 1901-2, 1902-3, 1903-4 and 1905-6 to 1909-10; cadet system 1909-10; Courses of Reading, 1908-9; exhibitions, Canadian, 1907-8 to

1909-10; hedges 1905-6 to 1909-10; insects and insecticides, 1906-7 to 1908-9; lectures to teachers, 1901-2 to 1903-4; limes, 1901-2, 1908-9 and 1909-10; millions, 1905-6; nutmegs, 1901-2 and 1902-3; Permanent Exhibitions Committee, 1907-8 to 1909-10; pine-apples, 1902-3; plant fumigation, 1908-9 and 1909-10; rubber, Castilloa, 1904-5 to 1909-10; rubber, Funtumia, 1904-5 to 1909-10; rubber, Para, 1905-6, 1906-7, 1908-9 and 1909-10; school gardens, 1901-2 to 1904-5 and 1906-7 to 1908-9; stock, 1901-2 to 1909-10; tobacco, 1901-2 to 1903-4 and 1905-6 to 1909-10.

In 1901-2, seeds of cacao, nutmegs and limes were imported in considerable quantities for use on estates; and in regard to the first and second, another importation, for Nevis, took place in 1902-3. As regards cacao, the efforts to extend the cultivation were continued in 1904-5 and there were increases of the area cultivated, particularly in the next two years. Some of the cacao came into bearing in 1907-8, and signs of success showed themselves at one of the centres. In 1908-9, most encouraging results were received, and a further extention of the area in the crop was made. There was no increase of the area in 1909-10, but this was intended for the near future. An interest was being taken in lime cultivation, in 1908-9, both in St. Kitts and Nevis, and fairly large areas were being planted on two estates in the former island. The area was still steadily increasing in 1909-10, and plants were being raised at La Guérite to supply the demand, 60,000 being ready for sale.

An experiment in tobacco-growing was commenced at La Guérite in 1901-2; this included trials of fermentation, and in 1902-3 an unfavourable report was received on samples submitted to England, owing to faults in the drying and curing. The Report for 1903-4 states that Sumatra and Havana were being grown for curing. In 1905-6 an experiment made in growing plants from locally produced Havana seed, under cheese-cloth, showed unmistakably that tobacco, with good leaves suitable for cigar wrappers, can be grown in St. Kitts; another experiment in the open, and employing locally produced Sumatra seed, was also successful. In 1906-7 a report from London on samples forwarded during the previous year showed that the tobacco had not received adequate preparation; a continuation was made of growing tobacco under shade and in the sun; the conclusion from all the experiments, so far, was that tobacco could be grown in St. Kitts for the local market, but not for consumption in England. Experiments were made with Havana, Sumatra, and Virginia varieties in 1907-8, and samples were sent to London for report; the latter was more favourable, but it was stated that the burning qualities of the product were still deficient. The trials were continued in 1909-10 and more samples were sent to London and Barbados; the reports on these were not favourable. Information regarding rubber in St. Kitts shows that in 1904-5 plants of *Castilloa elastica* and *Ficus elastica* were raised at the Botanic Station, and the intention is expressed to extend rubber cultivation in the island. By the next year the plants had made good progress, and the area was increased by means of plants and seed from the Botanic Station. During this period, fifty plants of Para rubber were purchased from the Botanic Gardens, Trinidad; this is the first record of Para rubber n this Presidency. By 1906-7, between 4,000 and 5,000 trees of Castilloa and Funtumia were growing, the greater number being of the former kind; the progress was satisfactory. The Para rubber was also growing, but doubt is expressed as to its suitability to the limited rainfall of the island. By 1907-8, there were no indications, from the progress made, that either Castilloa or Funtumia would succeed very well as rubber-producing plants in St. Kitts; the trees were therefore being used as shade and wind-breaks for young cacao, and it was intended to extend their employment in this connexion. *Ficus elastica* fruited in 1908-9, and during this time plants of Para were being raised at the Station for experiment. Castilloa and Funtumia were growing well in 1909-10, and plants of Para raised at the Station were planted out on estates.

It should be mentioned that reports on Agricultural Education at the St. Kitts Grammar School have been rendered regularly since 1902-3.

NEVIS.

STAFF.

The experiment Station at Nevis, which is regarded as a branch of that in St. Kitts, was started in 1903-4, with G. Walwyn as Agricultural Instructor. In 1904-5, Mr. J. S. Hollings was appointed in temporary charge of the Station, and to perform the duties of Agricultural Instructor In the next year, Mr. Hollings held the post of Agricultural Instructor and at this time the first independent report on the Station was issued. Mr. Hollings resigned in 1906-7, and for part of this period, Mr. J. O. Maloney was stationed in Nevis for the special purpose of assisting peasant cultivators to combat the cotton worm, which had become a serious pest. In 1907 8, Mr. Maloney was appointed as Agricultural Instructor, and holds the post at the present time; this officer received six months' sick leave in 1909-10, and his duties were performed by Mr. C. C. Greaves.

ORNAMENTAL AND USEFUL PLANTS.

As is stated above, the branch station at Nevis was formed in 1903-4. It exists solely as an experiment station, and little attention is given to the collection and growing of permanent ornamental or economic plants. A further use of this Station is for the purpose of distributing planting material.

ECONOMIC EXPERIMENTS.

EXPERIMENTS WITH STAPLE CROPS.

COTTON. In 1904-5 planting distance experiments gave results similar to those obtained in St. Kitts; during the time, manurial experiments were conducted by planters, and this was the case in the second year, reports of the returns being sent to the Antigua Agricultural Department. Planting distance experiments in 1905-6 supported the former results. In the next year a successful experiment was made in growing Sea Island cotton and in the control of cotton pests; the report for this period, as well as those succeeding it, gives an account of the progress of the industry in the island. Manurial experiments according to a definite scheme, as well as other trials for the purposes of demonstration, have been continued since 1908-9 up to the present time; in this year Stirling seed was raised at the Station. In 1909-10, a trial of the Heaton variety of cotton was made, but this was found to be subject to boll-dropping. Experiments conducted during this period demonstrated that cotton should not be planted late in the season.

SUGAR. In 1909-10, varieties of sugar-cane were introduced and grown, 10,200 cuttings being distributed for planting, for trial, in different parts of the island; these included B.208, B.254, B.376, B.393, B.625, B.1753, B.4596, D.116, D.109 and Sealy Seedling. In the report for this period, an account of the sugar industry is given, and it is stated that an experiment with fifteen cane varieties was commenced at Pinneys estate.

EXPERIMENTS WITH PROVISION AND OTHER CROPS.

Information concerning experiments with these appears as follows:—

PROVISION CROPS.	1904-5.	1905-6.	1906-7.	1907-8.	1908-9.	1909-10.
Sweet potatos	+		+	+		+
English potatos	+					
Yams	+	+	+	+	+	+
Eddoes	+				+	+
Onions	+		+		+	+
Cassava		+	+	+	+	+
Yam bean		+	+			
Cowpeas			+		+	+
Pigeon peas			+	+		
Ground nuts				+	+	+
Soy bean						+
CORN AND MILLET CROPS.						
Guinea corn	+	+	+		+	
Maize		+			+	
Broom corn			+	+	+	+
GREEN DRESSING CROPS.						
Velvet beans		+				
Cowpeas			+			
Pigeon peas			+	+		
PASTURE AND FODDER CROPS.						
Guinea corn	+	+	+			
OIL CROPS.						
Castor oil plant				+		
Ground nut					+	+
Soy bean						+

In regard to Guinea corn, experiments with a variety called Turks Island showed that this was very effective as a wind-break, but the best yields, by far, were obtained from the kind called Guinea wheat, which had been secured by the Commissioner of Agriculture at a recent agricultural show in the Island. Colombian varieties of cassava failed in Nevis, as in St. Kitts, and from the same causes. In 1907-8 and 1909-10, the variety of cassava called Black Stick gave success similar to that which has been obtained in St. Kitts. Continued experiments with onions have shown that these can be produced and exported successfully, but a more extended market is required for the industry. By 1909-10 the small industry started five years before had gradually increased, and during the year onion seed imported from Teneriffe, through the Imperial Department of Agriculture, and otherwise, was sold to planters at cost price. Trials reported with broom corn, ground nuts and the soy bean have not been successful.

MISCELLANEOUS CROPS AND SUBJECTS.

Information is available in the reports as follows: Agricultural and Commercial Society, 1904-5 and 1905-6; agricultural shows, 1904-5 to 1908-9; Arbor Day, 1908-9; cacao, 1904-5 to 1909-10; capsicums, 1904-5 to 1907-8; crop enemies, 1904-5 and 1905-6; hedges, 1907-8 and 1909-10; hemp (*Cannabis sativa*), 1904-5; limes, 1905-6 to 1909-10; school gardens, 1904-5 to 1906-7; soil analysis, 1906-7; stock, 1904-5 to 1908-9; wind-breaks, 1905-6 and 1906-7.

In the Reports for 1904-5 to 1906-7, an account is given of the crops and general prospects of the island; those for 1907-8 and 1908-9 contain information concerning minor industries. The details regarding school gardens show that these have made good progress and obtained a fair success, in Nevis. In the Report for 1905-6, hints are given on drying and shipping capsicums; at this time about 10,000 lime plants were raised at the Station, and 5,300 were sold from the nursery as compared with 5,732 in 1906-7 and 3,600 in 1907-8. The records for 1908-9 show that orders were received for 80,000 lime plants for putting out in 1909, and in 1909-10 the distribution of lime seeds and seedlings was continued.

VIRGIN ISLANDS.

STAFF.

In 1902-3, Mr. W. C. Fishlock was appointed as Agricultural Instructor in charge of the Experiment Station, in the place of Mr. C. W. Seale, who had resigned. Mr. Fishlock, who holds the post at the present time, was granted leave in 1909-10, and during this time the foreman, E. Maduro, took charge, followed by Mr. Esmead of St. Kitts.

ORNAMENTAL AND USEFUL PLANTS.

The Experiment Station is situated in Tortola, on the site of a partly abandoned sugar estate; work was commenced in it in 1900. The purposes for which it is intended do not include its use as a centre for growing to any great extent permanent plants of an ornamental or economic nature. Further particulars of this Station may be found in the Report for 1906-7.

ECONOMIC EXPERIMENTS.

EXPERIMENTS WITH STAPLE CROPS.

COTTON. The Report for 1903-4 shows that Sea Island cotton was sown at the Station, and details of the expenditure and value of the crop are given; at the same time success is predicted in the event of the adoption of the crop, for growing, by the peasantry. Subsequent reports include an account of the cotton industry; that for 1904 5 shows that the cotton grown at the Station at the time was practically a failure, owing to unavoidable late sowing. In 1905-6, a successful trial was made of St. Vincent seed, while experiments showed that the seed produced locally was very mixed in nature, and that there was great need for careful selection. Experiments conducted in 1906-7 indicated the necessity for early planting, and the report for this period includes an appendix on the working of the cotton factory. The usefulness of early planting, for cotton, was further demonstrated in 1907-8 and 1909-10. A final matter of interest is that, by 1907-8, the cotton-growing industry was regarded as becoming well established, and the detailed information given regularly in subsequent reports shows that this view was correct.

SUGAR. This and the following industry are quite subsidiary to cotton-growing, although in regard to limes there are indications that the importance of these may greatly increase. Returning to matters concerning sugar, the Report for 1901-2 shows that about 1 acre of seedling canes was planted; sugar was made from these in 1903-4, during which period B. 147 was raised. In 1904-5, success was obtained with B. 147, and cuttings were distributed; another 1-acre plot was planted in B. 109, B. 208, B. 306 and Sealy Seedling, the best results being obtained with the second. Sugar-making from canes grown at the Station and for the peasantry has continued since. In 1905-6, B. 147 was still showing its superiority, under local conditions, and experiments were continued with it for the purpose of encouraging the peasantry to raise enough sugar for local requirements. The success with B. 147 continues to be reported in 1906-7, 1907-8 and 1909-10, while B. 208 in 1906-7 and 1907-8 is recorded as being likely to fail in drought, and to be best suited for growing in rich, moist soils; the suggestion was made that it might be raised in swampy lands. In 1908-9, it is recorded that the cultivation of the varieties was continued and that about 50 barrels of sugar were made at the Station.

LIMES. About 2 acres of limes was planted at the Station in 1902-3; disappointing results are reported in the next two years, as well as attacks of scale insects. In 1906-7, the suggestion is made that limes might be bought from the peasantry, and it was also hoped that a small citrate of lime industry may be established. In 1907-8, spineless limes that had been introduced from Dominica in 1906 were planted out; during this period there were indications that the efforts of the Agricultural Department to establish a lime industry will meet with some success. It is recorded in 1908-9 that the lime plot was showing improvement, having been given more attention; note is made that a form of modified scuffle hoe was found superior to the draw hoe for use in lime plantations. It is in the Report for this period that an account of a definite lime industry in the Virgin Islands is first presented, and it is shown that 40,273 ℔. of limes (about 252 barrels) was bought from the peasantry; while 200 gallons of raw juice and 3 casks of concentrated juice were shipped, a favourable report on the latter being received subsequently from London. It remains to be mentioned that the information for 1909-10 includes the circumstance that the usefulness of the provision of wind-breaks for lime trees had been demonstrated.

EXPERIMENTS WITH PROVISION AND OTHER CROPS.

The various reports deal with these as follows:—

	1902-3.	1903-4.	1904-5.	1905-6.	1906-7.	1907-8.	1908-9.	1909-10.
PROVISION CROPS.								
English potatos	+	+	+	+	+	+		
Sweet potatos	+						+	+
Yams		+	+					
Onions	+	+	+	+		+		+
Pigeon peas				+	+			+
Yam bean				+				
Cassava					+	+	+	+
CORN AND MILLET CROPS.								
Maize			+					
Guinea corn			+					
Broom corn								+
GREEN DRESSING CROPS.								
Pigeon peas				+	+			
Alfalfa				+				
Canavalia ensiformis				+				
PASTURE AND FODDER CROPS.								
Guinea corn			+					
OIL CROPS.								
Ground nuts								+

Fair reports of shipments of onions to Canada and the United States are recorded in 1903-4, at which time indications were obtained that a successful onion industry might be established. In the next two years experiments showed that transplanting from nursery beds was the best method for raising onions in Tortola, while in the latter period it was demonstrated that October is the best month, under normal conditions, for sowing the seed. Trials with onions in 1907-8 proved that if onions are strung carefully and hung up where it is cool and where there is plenty of air, the bulbs can be kept in good condition for at least three months. Lastly, trials have shown that English potatos cannot be grown successfully in Tortola near the sea-level; they give good yields, however, at an elevation of about 1,000 feet.

MISCELLANEOUS CROPS AND SUBJECTS.

Information in the several reports is given as follows: agricultural shows, 1902-3 to 1906-7; Arbor Day, 1904-5; arrowroot, 1902-3 to 1906-7, and 1908-9 and 1909-10; bee-keeping, 1904-5; cacao, 1902-3 to 1909-10; capsicums, 1902-3; coffee, 1902-3, 1903-4 and 1906-7 to 1909-10; exhibitions, Canadian, 1908-9 and 1909-10; ginger, 1902-3; kola, 1903-4; oranges, 1903-4; peasant proprietors' plots at the Station, 1903-4 to 1905-6; pine-apples, 1902-3 to 1909-10; rubber, Castilloa, 1905-6 and 1907-8; stock, 1902-3 to 1905-6; tobacco, 1907-8; tous-les-mois, 1902-3 to 1906-7, and 1908-9 to 1909-10; wind-breaks 1904-5 to 1907-8.

Trials made with pine-apples in 1903-4 showed that these make good growth in Tortola; continued success was obtained with the variety Black Antigua; a chief requirement was the provision of a market for the produce. In 1907-8 the Black Antigua was still succeeding well, but the Smooth Cayenne in the experiments had gradually died out, in the last few years. New varieties in the shape of Red Spanish and Cabezona were introduced in 1908-9. Cacao planted at the Station did not meet with success at first, but there was an improvement later, until in 1904-5 trees planted in 1902 were bearing a few pods. In 1905-6, the plants at the Station were in a promising condition and others were being raised for distribution, in consequence of the larger general interest that was being taken in the crop. Good progress was made in 1906-7, and satisfactory reports were obtained on samples of cacao sent for examination to London. An extension of the cacao plot took place in 1907-8, by which time there were indications that much shade is inimical to the growth of cacao in the Virgin Islands. The observation was made in the next year that the best method of establishing cacao plants at the Station is by sowing seeds at stake; drought seemed to have less effect on plants raised in this way. A last matter of general interest is that the Report of 1909-10 makes mention of special meetings of peasants, that were held by the Agricultural Instructor in connexion with the cotton and lime industries.

DISTRIBUTION OF ECONOMIC PLANTS FROM THE STATIONS.

The following table of the distribution of economic plants (besides seeds and cuttings) from the Stations has been compiled from information in the Annual Reports and in the *West Indian Bulletin*, Vol. VII, p. 386 : –

	1901–2.	1902–3.	1903–4.	1904-5.	1905-6.	1906-7.	1907-8.	1908-9.	1909-10.	Total.
Grenada	8,794	7,584	5,657	3,534	4,532	7,588	3,216	7,938	3,474	52,317
St. Vincent	24,033	7,670	13,536	26,256	17,543	12,050	6,196	6,660	11,781	125,725
St. Lucia	15,461	26,637	10,216	13,103	25,675	64,850	74,644	43,492	77,557	351,635
Dominica	60,533	57,131	53,500	46,736	65,731	83,505	53,855	67,596	79,009	567,596
Montserrat	11,817	19,737	19,690	14,887	6,774	11,975	8,183	11,857	23,731	128,651
Antigua	6,465	2,961	1,928	1,415	2,561	2,880	14,522	78,256	180,696	291,684

In the above table, the figures for Barbados, St. Kitts-Nevis and the Virgin Islands are not included, as the records from the sources mentioned are not complete. It should be mentioned that the above figures include cane cuttings, which have formed a large part of the distribution, in some cases.

GENERAL PROGRESS IN THE WEST INDIES. SINCE 1897.

It is, at this period, a matter of very considerable interest to compare the general position of the West Indies, in regard to their agricultural prosperity as they appear now and as they appeared in 1897, when the Royal Commission issued its Report, one of the consequences of which was the creation of the Imperial Department of Agriculture.

In the earlier period, very considerable anxiety existed as to the stability of the sugar industry, which was in danger of giving way under the competition against the beet sugar industry fostered by a system of bounties and cartels. The cacao industry was confined to limited arears, and was moderately prosperous; but the conditions required by this crop did not permit of such an extension as would carry prosperity to the sugar-growing colonies. Fruit-growing was making some headway, but only in Jamaica, and for the product of that Colony the only outlet was the United States, there being no facilities for carrying fruit to England. The cultivation of limes formed the basis of a small industry in two or three colonies, from which raw and concentrated lime juice was exported, and the regular demand for these products ensured a measure of prosperity for those engaged in the industry.

The removal of the bounties upon beet sugar placed the West Indian sugar industry upon a stable footing, and made economically possible the introduction of fresh capital for the better cultivation of estates, and for the substantial improvement of machinery; the organization of large factories was begun, and a movement set on foot of which only the early stages have been reached; for it is the work of years to restore credit to an industry that had been regarded doubtfully for nearly a quarter of a century. Relief from the depression that had weighed so heavily upon the sugar industry resulted in considerable agricultural activity, and this activity extended beyond the bounds of the sugar industry itself.

The introduction of the successful cultivation of Sea Island cotton, after a year or two of careful experiment, brought into existence an industry that found many openings in those islands where sugar-growing had formerly been the sole industry After the years of experiment, many thousands of acres were brought under cotton cultivation, and a new and important source of wealth was made available for the West Indian agriculturist. In this, much of the success is due to the assistance of the British Cotton Growing Association.

The cultivation of rice has assumed large proportions in British Guiana, and, among other matters, the steady work that has been done by the Agricultural Authorities in the Colony has led the latter, from being an importer of rice, to become a source of supply for the West Indies, the production having risen very greatly in recent years.

The lime industry has received much attention and has been extended in Dominica, though indications are not wanting that the cultivation of this crop will be followed on a considerable scale in an increasing number of the West Indian colonies, in the near future.

The fruit industry has made immense strides, particularly in the production of bananas in Jamaica and latterly in Trinidad; the establishment of a direct line of fruit-carrying steamers between Jamaica and England having provided a most important stimulus.

The cacao industry has steadily mantained its position, and has been extended in those islands whose soil and climate are suitable for this. It is to be noted that cacao growing is now improving in its scientific aspect; the various pests and diseases to which the crop is subject have been the object of much study, so that now they are understood far more adequately than in the earlier period referred to, and consequently, they are more regularly and efficiently controlled. In addition to this, more attention is given to methods of cultivation and the preparation of the product for market, while there are now small commercial areas planted with grafted cacao, and it seems probable that the practice of grafting cacao will soon become regularly accepted in the establishment of new plantations.

In all this there is evidence of considerable agricultural awakening, and of restored confidence in the prosperity of West Indian agricultural enterprises, so that there now exists a spirit of progress contrasting strongly with the depression and despondency so frequently referred to by the Royal Commission of 1897.

It cannot be claimed that the Imperial Department of Agriculture is the cause of all this improved condition, but it can reasonably be held that when matters began to be ameliorated, largely as the result of the abolition of bounties, the work of the Department was ready to be availed of by those who were prepared to move forward, while this work and the dissemination of information and knowledge, by means of reports and publications of the Department, stimulated agriculturists to activity and materially hastened progress. The presence in each agricultural community of scientific officers, capable of giving expert advice, and themselves linked up with the Central Office of the Imperial Department of Agriculture, provided an organization that was capable of directing individual effort along right lines, while it repressed or eliminated ill-conceived or unsound proposals—a condition of affairs that made eminently for progress.

The stimulus which the Imperial Department of Agriculture gave to the local departments of agriculture, and above all, the assurance created that matters of agricultural interest were in future to form an important part in the administration of the colonies, resulted in an output of energy in experiment stations and in private enterprises which had a most important effect on the mental attitude of those connected with agriculture; a desire to develop new lines and to exploit new fields has taken the place of the former indifference, and this alone will, with a little fostering care, ensure still further progress in the near future.

A brief survey of the conditions of some of the colonies may be instructive; this is confined to the interests of the Lesser Antilles.

GRENADA. The decadent sugar industry of this Colony having been replaced by a flourishing cacao industry some years before 1897, the Royal Commission of that year found Grenada in a more prosperous condition than most of her neighbours—a condition of prosperity that has been well maintained. The Report of the Royal Commission contains this passage (par. 328, p. 42): 'There are many small proprietors in the island who cultivate their own lands, and with careful administration, we see no ground for any special apprehension regarding the future, nor any reason to suppose that the Imperial Government will be required to give financial assistance.' The value of scientific investigation into agricultural problems is now fully realized, and provision is made for carrying on work of this kind for the benefit of the Colony.

During recent years, much attention has been given to matters connected with the improvement of the cultivation and preparation of cacao; the pests and diseases to which the crop is liable have been carefully studied, and provision is made for the continuation of this work of investigation so as to enable the industry to meet any difficulties that may arise.

Owing to over-production, the cultivation of nutmegs has not been as advantageously carried on in recent years, as it was formerly.

CARRIACOU. The condition of Carriacou has greatly improved in recent years; the development of a successful Land Settlement Scheme has much ameliorated the condition of the island, where the cultivation of cotton (chiefly of the Marie Galante type), corn and food stuffs is actively carried on. Lime-growing promises to be of some importance within a very brief period.

ST. VINCENT. The condition of this Colony, as recorded in 1897, was one of extreme depression. This was further accentuated by a disastrous hurricane in 1898, while the difficulties of the situation were increased by the eruption of the Soufrière, in 1902, whereby many lives were lost and much damage was done to property, several estates being covered with the ejected ash and stones.

In 1897, the Royal Commission regarded the outlook as serious and recorded (Report, par. 373, p. 48) that in view of the approaching extinction of the sugar industry in St. Vincent and of the fact that there is no prospect of private enterprise establishing other industries on a sufficiently large scale to afford employment to the labouring classes, the problemn of providing for these classes becomes one of extreme urgency and is beset with difficulties. 'Wages are very low; . . . there is a lamentable want of continuous employment . . . the population is decreasing and the labouring classes are discontented.' (Report, par. 368, p. 47.)

This picture is in striking contrast with the present position. The development of a large and successful Land Settlement

Scheme has provided many of the labouring population with land which they now own and work to great advantage. There has also been developed in St. Vincent a flourishing cotton industry —a matter in which the British Cotton Growing Association has afforded its useful assistance—and cotton has now becom the principal product of the Colony.

At the same time, increased attention has been given to arrowroot, and it would appear that this industry is in some measure recovering its position. The recent formation of an Arrowroot Growers' and Exporters' Association should aid materially in this.

The exports of the Colony have increased considerably in value in recent years; they are as follows:—

Year.	Exports.
1900*	£97,769
1901	51,987
1902	44,094
1903-4	38,174
1904-5	51,902
1905-6	53,078
1906-7	83,755
1907-8	94,265
1908-9	94,739
1909-10	88,698

(*Abnormal business in arrowroot.)

The sugar industry of St. Vincent has become very small. There are, however, indications of revived interest in it, and the question of its restoration on modern lines in certain districts is under consideration.

BARBADOS. Being very largely dependent upon the sugar industry, this Colony was depressed and apprehensive in 1897. In the Report of the Royal Commission of that date the position is stated as follows (par. 227, p. 31): 'The state of things in Barbados and the outlook may be summed up by saying that there is but one industry upon which the population and the revenue are absolutely dependent; that this industry is now without credit, and is to a considerable extent being carried on at a loss, while, for special reasons the distress caused by the failure of it will be exceptionally severe, and there is practically no other industry or industries which can be substituted for the production of sugar so as to maintain the population and provide sufficient public revenue.'

The removal of the bounties on European beet sugar in 1903 afforded great relief, so that the sugar industry at once assumed a more stable and prosperous position. As the sugar produced is mostly of the muscovado type, the industry is very largely dependent upon a ready and remunerative sale for molasses; in this commodity Barbados felt seriously the competition of Porto Rico. Owing to changes in the method of sugar production consequent upon the American occupation of that island, its output of molasses has rapidly declined, thus diminishing the competition and leaving the market open for molasses from Barbados and other British West Indian colonies. These changes enabled the production of muscovado sugar to be carried on profitably, so that less apprehension existed and a measure of prosperity returned

There was grave danger that, on the abolition of the bounties on beet sugar, the admission of that commodity into the markets of the United States would deprive Barbados, in common with other British West Indian Colonies, of a market for muscovado sugar. This danger was averted by the opening of the Canadian market, on account of the preferential treatment accorded to British-grown sugar, so that from 1904 a large proportion of the sugar has found a market in the Dominion.

At the present time, the question of the permanence of the muscovado industry is being discussed, and there is a growing tendency to modify the machinery employed and to engage in the manufacture of crystal sugar produced in vacuum pans.

Cotton-growing has been carried on in Barbados on a fair scale in the last few years; this has added in no inconsiderable degree to the agricultural resources of the Colony and has proved a valuable rotation with sugar.

A small but promising trade in bananas was being built up a few years ago. This, however, had to be abandoned on account of inadequate shipping facilities.

No material change has taken place in the area of land under sugar cultivation; the fluctuation in the crop produced is mainly due to seasonal causes. (See *West Indian Bulletin*, Vol. X, pp. 56 and 57.)

ST. LUCIA. In this Colony, sugar cultivation was long the most important industry; in 1897 the Royal Commissioners found the muscovado part of the industry verging on extinction, but there was an output of some 3,000 to 4,000 tons of crystal sugar from four factories. The future of these factories at that period was extremely doubtful, as indeed was that of the sugar industry throughout the whole island.

Next to sugar in importance came the cultivation of cacao—an industry which at that period had already obtained a firm footing in the Colony.

In addition to that from agricultural resources, St. Lucia has received assistance from several circumstances. The development of the Harbour of Castries so as to permit of the creation of a fairly extensive coaling trade has been of very great importance industrially; while the construction of military works and the quartering of soldiers in the Colony for several years led to the circulation of considerable sums of money. These facts masked, to some extent, any agricultural depression.

The improvement of the conditions of the sugar trade by the abolition of bounties has enabled the sugar factories to be carried on profitably, and in the last year or two substantial improvements have been made in respect of the machinery of some of them; so that sugar still holds its place as the chief agricultural industry.

In the ten years following the visit of the Royal Commission, the exports of cacao nearly doubled, and progress is still being made. Attention is being directed towards the cultivation of limes, and partly to rubber.

Generally speaking, St. Lucia may be regarded as a colony possessing much scope for agricultural development—as being in fact very imperfectly developed from an agricultural point of view, but a colony where such agriculture as exists is fairly prosperous.

DOMINICA. At the time when the Royal Commission visited Dominica, it is recorded that the sugar industry had largely been abandoned, and that the failure of this industry had not been unaccompanied by distress. (Report, pars. 292 and 393, p. 50.) The Report goes on to say: 'It is with the development of the other industries that the Colony will be mainly concerned in future. In this direction, there is not only very good ground for hope but considerable progress has already been made.' (Par. 396, p. 50.) Further on (pars. 409 and 410, p. 52), the direction is indicated in which success may be sought, namely in an extension of the cacao, lime and fruit industries, and the provision of the conditons best calculated to foster these. Since that period, Dominica has followed the line of progress thus laid down, and has attained a condition of prosperity.

During the past few years, agricultural enterprises have been vigorously pushed forward in Dominica; many of the old and partially abandoned estates have been brought into cultivation in limes and cacao, while many estates have been developed in districts that were recently covered with forest. The cultivation of the crops just mentioned is the principal agricultural interest, but the growing of oranges and other citrus fruits, and of vanilla and rubber, also engage attention.

It is interesting to note that a large proportion of the trees and plants required to develop these new enterprises has been obtained from the economic nurseries attached to the Botanic Gardens. These Gardens have played a leading part in the present active development of the Presidency; for not only have they supplied a large amount of the material required for planting, but the advice and guidance of the officers attached to them have been very extensively sought by those undertaking new developments. At the same time, these officers have exercised a careful supervision of the general agricultural affairs of the Presidency, indicating what crops are likely to be suited to certain districts, maintaining a careful watch for plant pests and diseases, and recommending measures of eradication or control. All this work has been carried on in close association with the Imperial Department of Agriculture.

Quite recently there has been developed an important scheme for the utilization by a company of the timber in the forests of the northern part of the island. Care is being taken to avoid denuding the exploited areas which must be beneficially occupied. It is probable that this development will lead to the opening up of considerable tracts of fertile land for the extension of planting in cacao, limes, rubber and other products..

The present tone in Dominica is one of healthy agricultural activity, and evidence of depression has entirely passed away.

MONTSERRAT. The condition of Montserrat when the island was visited by the Royal Commission was one of retrogression, owing to the decadence of the sugar industry; but this was not attended by much distress, from the fact that the peasantry had ready access to land and was thus able to supply its more immediate needs. The value of the exports of sugar had fallen to some £5,000, having in the previous decade had a value of over £20,000. The lime industry came next to sugar in importance, the value of the exports fluctuating considerably, but averaging about £6,500. (Report, Appendix A, p. 128.)

At that time the peasantry could find little employment, and it appeared as though the cultivation of products for export was falling to a very low ebb, and that the majority of the people were engaged in obtaining merely their own food supplies from the soil.

In 1899, the island was visited by one of the most disastrous hurricanes on record, and disorganization was complete. The sugar works were practically all destroyed and the lime plantations suffered severely. The exports of the island in 1900 fell in value to £8,287, and of this, cattle and stock contributed £3,187, leaving only £5,100 as the value of all the other exports.

By a fortunate circumstance, about the years 1901-2, attention was being directed to cotton-growing in the West Indies, and Messrs. Sendall and Wade subsequently began planting on a commercial scale, so that, writing in 1905, it was possible to report: 'Cotton-growing has now become an important industry, and upon this it would seem the development of the island in the immediate future directly depends.' (*Colonial Reports*, Miscellaneous, No. 34, p. 10.)

Montserrat is now in a flourishing condition; its people are fully employed, and indeed there is now heard the complaint that there are insufficient labourers to permit of the development of agricultural industries. The cultivation of cotton has principally engaged attention, though the restoration of the lime plantations after the hurricane of 1899 has been prosecuted with vigour, so that now the lime industry is again quite re-established.

The attention given to cotton has absorbed most of the energies of the people, and other industries than cotton, limes, food crops, and to a minor extent sugar, have not received much attention; it is probable that this condition will obtain until cotton-growing has attained its maximum development, when local agriculturists may find occasion to attempt to exploit other industries.

With this agricultural awakening, the public finances of the Presidency have improved, and after a period of dependence upon Imperial financial assistance, the revenue now adequately meets expenditure.

In Montserrat there is afforded an instance of a complete change in the destiny of a small community within a few years, by the successful introduction of a new industry; in attaining this, those responsible for the commercial side of the work were adequately assisted by the scientific work and investigations of the Department of Agriculture, particularly in determining and selecting the kind of seed to be used, and in controlling the various pests to which cotton is subject; and almost indispensable aid was also given by the British Cotton Growing Association.

ANTIGUA. Of all the West Indian islands, Antigua at the time of the visit of the Royal Commission, probably presented the most difficult case, and gave cause for the greatest apprehension as to the future. Practically entirely dependent upon sugar, with the future of the sugar industry appearing most gloomy, and with the existence of droughts, pests and diseases of sugar-cane, and imperfect machinery for the manufacture of sugar, it was difficult to point to any hopeful feature.

The Royal Commission stated: 'At present prices the sugar industry is in a very depressed condition, and if there is no improvement the diminution of it within the next few years will be great. On the whole, at present prices it is not remunerative. . . . . The evidence given as to the condition of the people went to show that poverty is increasing and houses falling into dis-repair, and that, generally, a state of depression exists, which cannot but cause suffering and discontent . . . . . . In the event of a failure of the sugar industry the condition of Antigua will be one of very great distress and difficulty. No other industries can supply the place of sugar.' (Report, pars. 435, 438, and 440, p. 45.)

The abolition of the bounties in 1903 as the result of the Brussels Convention greatly ameliorated the condition of the sugar industry; a still further impetus was given by the successful establishment of a central sugar factory, on a fairly large scale, by the Antigua Sugar Factory Co., Ltd. This factory has proved a most valuable object-lesson, not only for Antigua, but also for many other colonies, and has answered in an unequivocal manner many of the questions that have been debated for upwards of thirty years.

A very active part was taken by the Department of Agriculture in the efforts leading to the establishment of the Antigua Sugar Factory; all available information was gathered for the guidance of the promoters, and all assistance was rendered at the various stages of development.

In consequence of the abolition of bounties in 1903, British West Indian sugar ceased to find an advantageous market in the United States; the preferential treatment accorded in Canada to British-grown sugar now turned the current of sugar exports to the Dominion. Consequently since that period, Antigua in common with other British West Indian colonies, has been largely dependent upon the Canadian market for the advantageous sale of its sugar.

As the outcome of these developments, the threatened decadence of the sugar industry has been arrested and there are now signs of increased prosperity for this.

Some attention has been given to other industries. The cultivation of cotton began on a small commercial scale in 1903-4, with the aid of the British Cotton Growing Association. After quickly increasing in importance, it has rapidly declined owing to unpropitious seasons and the attacks of a pest so far confined to this island—the flower-bud maggot (*Contarinia gossypii*).

During the past two years, however, the area under cultivation has been increased.

The cultivation of limes is now receiving attention, as are minor industries. While it is recognized that Antigua has effected substantial progress towards prosperity, it will require much energy and careful work to make the position an assured one. The recent progress may perhaps be judged by the improvement in the public finances.

Year.	Revenue.	Expenditure.
1897	£46,330	£53,417
1898	39,663	55,586
1899	42,822	51,959
1900	42,652	49,435
1901-2	42,067	48,514
1902-3	46,395	48,992
1903-4	43,812	50,209
1904-5	44,295	48,670
1905-6	48,798	54,383
1906-7	44,175	45,207
1907-8	50,620	46,968
1908-9	51,502	49,964
1909-10	48,583	49,024*

(* Including £5,771 repayment of loans.)

BARBUDA. It may be added that the island of Barbuda, which is the property of the Government, has, owing to the successful development of a cotton industry, also with the aid of the British Cotton Growing Association, become prosperous and has ceased to be a financial burden to Antigua, but, on the contrary, contributes to the revenue.

ST. KITTS-NEVIS.—The Commission records that the conditions in the islands of St. Kitts and Nevis, in that they were dependent upon their sugar industry, approximated somewhat closely to those of Antigua, and that their prospects were no better. (Report, par. 453, p. 57.) It was stated in evidence that orders had already been sent out from England to the attorneys of several estates to stop cultivation as soon as the present crop was reaped. On such estates, the Report states, there would then until the next crop, be little work to be done, and in about two years employment would cease altogether. It was intimated that this decision to cease cultivation had reference to no less than one-fourth of the estates.

Note was made that the condition of St. Kitts differed from that of Nevis in that, in the latter island, the peasantry had more access to land and was better able to sustain itself in the absence of the sugar industry.

In *Colonial Reports*—Miscellaneous, No. 35, p. 13, it is stated: 'In the early nineties cane diseases were observed in St. Kitts; at first the loss occasioned was not great, but the trouble increased until it culminated in the disaster of 1900. In this year some of the estates were in so bad a condition that ruin seemed imminent. From that time onward strenuous efforts were made to substitute new and resistant varieties with great success, so that, now, cane diseases cause little anxiety.'

Owing to the fertility of the soil of St. Kitts and the care with which it is tilled, the sugar industry in that island has not suffered as great a depression as in Antigua. On the abolition of the sugar bounties and the recovery from the ravages of sugar-cane diseases, the industry soon became more prosperous. When the success of the central sugar factory in Antigua became evident, efforts were made to secure a similar factory in St. Kitts. It is gratifying to record that there is now in course of erection in St. Kitts a modern sugar factory on a more extensive scale than that in Antigua.

Although the sugar industry of Nevis has revived in some degree, its recovery is less marked than in the case of St. Kitts. It now remains to be seen whether it may be possible to follow the example of the neighbouring island and secure the introduction of modern machinery.

The introduction of cotton-growing, with the assistance of the British Cotton Growing Association, has been of very great benefit to both islands. In St. Kitts, cotton is very readily cultivated, so that the industry has become well-established and remunerative. In Nevis, it has assumed a high degree of importance, though it has had to face considerable difficulties, chiefly of a climatic character. At the present time, cotton-growing has become the principal industry of Nevis. It is interesting to note that in the season just closed the cotton crop of Nevis has reached the largest quantity exported from that island since the re-introduction of the industry.

Nevis suffered somewhat severely from the effects of the hurricane of 1899, but has now recovered.

St. Kitts may now be regarded as possessing remunerative and thriving industries in sugar and cotton, and as displaying a healthy agricultural activity, so that the former depression has completely passed. In Nevis, conditions are somewhat more critical owing to there being greater uncertainty, through unpropitious seasons, and the fact that the soil is less productive than that of St. Kitts. There is, nevertheless, a spirit of progress abroad, and very commendable activity on the part of proprietors of estates, and on that of peasant cultivators.

ANGUILLA. Reference may be made to Anguilla, a dependency of St. Kitts. A few years ago, the administration of the island caused considerable anxiety on account of the poverty of its resources. Subject to droughts and with no established industries, the island at times furnished a very precarious living to its inhabitants, and relief from St. Kitts not infrequently had to be supplied. Upon the establishment of cotton-growing in the neighbouring islands, attempts were made to cultivate this crop in Anguilla, and these, guided by the Imperial Department of Agriculture and aided by the British Cotton Growing Association, have met with a considerable degree of success. The Administrator of the Presidency of St. Kitts-Nevis writes (*Colonial Reports*—Annual, No. 673, p. 28): 'The cultivation of cotton has proved an immense blessing to the Presidency, especially to the island of Anguilla, which it has rescued from the most abject poverty.'

It is thus seen that the whole Presidency presents a brighter aspect, and is actively engaged in agricultural developments. The developments at present take largely the form of improving and extending the cotton and sugar industries, and these activities occupy to a great degree the energies of the available workers, including the labouring population. As these two industries attain their full extent, it is likely that more attention will be given to others; there is indeed evidence of this in the direction of experimental plantings of cacao, vanilla, cocoa-nuts and other crops.

THE VIRGIN ISLANDS. The Report of the West India Royal Commission of 1897 does not deal with the agricultural conditions of the Virgin Islands, and thus does not afford a standard for a comparison of the present with the past. A very fair picture of the conditions in 1904 is given, however, in *Colonial Reports*—Annual, No. 478, p. 47, where it is stated: 'The population of the Virgin Islands is about 5,000, and is largely a sea-faring one: the whole of the land is in the possession of negro peasant proprietors who never feel the pinch of poverty. The women do little work, the men can always get employment in connexion with the shipping at St. Thomas, or earn good wages on the sugar estates in San Domingo. The negro here has no white planters to imitate, he leads a very secluded life; it is extremely difficult to induce him to plant new crops or adopt new methods of cultivation. Under these circumstances the work of the Agricultural Department must be very largely educational and immediate ecomonic results must not be expected.'

In view of the discouraging environment thus described, it is satisfactory to be able to record that a successful cotton industry has been established, with most beneficial results to this small community. Careful steps were taken to instruct the peasantry in the cultivation of cotton, and machinery for its ginning and baling was provided by the Government, through the Department of Agriculture, while to ensure success in marketing the cotton, arrangements were made for its purchase by the Government through the local Officer of the Imperial Department of Agriculture, so that the peasant has a ready cash market for his produce, close at hand. The value and growth of the cotton industry in the Virgin Islands are shown in the following table:—

Year.	Cotton shipped, in pounds.	Value. £
1904	1,250	35
1905	4,000	145
1906	7,807	265
1907	10,177	620
1908	32,520	1,800
1909	52,528	2,500
1910	23,139	1,520
1911	50,337	3,180

The introduction of the cotton industry into this small community has added materially to its prosperity, as is indicated in the following observations taken from *Colonial Reports*—Annual, No. 673, p. 33, having reference to the year 1909-10: 'The growth of prosperity in the Virgin Islands, and the improvement in the conditions of life among the inhabitants are noticeable from the disappearance of the thatched cottage and the erection in its place of one with a shingled and galvanized roof.

'The local shopkeepers greatly improved their stock-in-trade during the year under review, the effect of which has been, slowly but surely, to reduce the trade carried on by small boats between these islands and the Danish island of St Thomas. Road Town, in consequence, is gradually taking its proper place as the commercial centre of the Virgin Islands.'

This improvement is reflected in the increases in the imports and exports, as is shown in the following table :—

Year.	Imports, £	Exports. £	Total trade. £
1900	3,320	2,812	6,132
1901	3.048	3.204	6,252
1902	3,159	4,027	7,186
1903	4,631	5,602	10,233
1904	5,409	4,557	9,966
1905	5,511	5,077	10,588
1906	6,412	5,760	12,172
1907	7,009	5,951	12,960
1908	8,629	7,150	15,779
1909	7,579	7,519	15,098

Small as are this Presidency and its interests, it illustrates in a striking manner the changes effected in improving the conditions of life by means of a well sustained agricultural policy—a policy which owes its strength to the fact that the affairs of this small community are linked up with the general scheme of agricultural administration in force in these colonies.

AGRICULTURAL EDUCATION AND INSTRUCTION.

Previous to the establishment of the Imperial Department of Agriculture, many efforts had been made throughout the West Indies to afford some kind of agricultural teaching in schools and colleges of various grades. In planning the work of the newly founded department, the Commissioner of Agriculture applied himself actively to the task of assisting to maintain such efforts as were already being made, and to extending the work beyond the scope then attempted.

Owing to the manner in which these efforts were scattered among different communities and different classes in these communities, it may be convenient to devote the small space available for a review of the work to considering what has been done in connexion with the several classes of scholars and students in the West Indies.

Elementary Schools.

The idea was brought constantly before the local Governments that it is in the best interests of the community that the teaching in elementary schools shall, as much as possible, have relation to the surroundings and after-life of the scholars, and that in the West Indies this implies the introduction of forms of nature study that will direct the attention of the pupils to rural objects and matters of agricultural import. In practically all the elementary schools a good deal of attention was being paid to object-lessons, but frequently these had little bearing upon the conditions in which the scholars were living.

Efforts were therefore made to ensure that the teaching, particularly as far as object-lessons and similar work were concerned, should have an agricultural bearing and embrace the rudiments of sciences having relation to agriculture. Difficulty was at first experienced in that the teachers in the elementary schools had themselves received little instruction along these lines, and were often at a loss to know how best to approach these subjects from a pedagogic point of view.

In order to meet these difficulties, lectures and classes of instruction for teachers were arranged in various colonies. At these lectures, outlines of courses of study were indicated in order that the teachers by their own reading might become familiar with the principles of the subjects they were required to teach; at the same time pains were taken to show, as far as possible, how these subjects might be dealt with as matters of instruction in elementary schools. Great stress was laid upon experiments and demonstrations suitable for school use; this led to the consideration of methods involving experimentation with plants cultivated in pots and boxes, and then to proposals for the establishment of school gardens.

The following courses of lectures or classes for teachers have been given. In many cases they were accompanied by demonstrations and practical work conducted at a botanic or experiment station, and in these instances their value was considerably enhanced :—

Grenada, 1900 (two courses) and 1903.
St. Vincent, 1904-5.
Barbados, 1898, 1899, 1900, 1901, 1902-3.
St. Lucia, 1899, 1900, 1901, 1903, 1909.
Dominica, 1900, 1901.
Montserrat, 1900, 1901, 1902, 1906.
Antigua, 1900-1, 1901-2, 1903-4, 1904-5, 1905-6, 1906.
St. Kitts, 1902, 1903.

In order to aid the teachers in their work, a small handbook entitled *Nature Teaching* was prepared, with the object of providing a simple outline of scientific studies, having an agricultural bearing, and at the same time indicating various pieces of practical work and experiments capable of being carried out by the teacher or his pupils and affording directions for accomplishing this. In the Leeward Islands, again, a pamphlet entitled *Hints to Teachers* was prepared, for the purpose of assisting in the instruction detailed in the syllabus of science and nature study, in the Code governing the elementary schools of the Colony; this has been embodied to a large extent in *Nature Teaching* in connexion with the successive enlargements that this work has received in recent years. Further, in the Pamphlet Series, several issues have been made of a publication entitled *Hints for School Gardens* the scope of which has been greatly increased in the new editions. A small work dealing in a simple manner with Tropical Hygiene has also been prepared, for the Government of the Leeward Islands. It must be mentioned, lastly, although this is not one of the publications of the Department, that a booklet having the title *Suggestions for School Gardens*, by J. R. Williams, M.A., has been published by the Jamaica Board of Education.

Throughout these efforts care has been taken to ensure that the work shall have its full educational bearing, and attempts to introduce in any undue degree the teaching of agriculture in a technical sense have been discouraged, the work even of school gardens being made to serve the ends of education. The school garden, together with experiments with plants in boxes and pots, has possessed the functions of a laboratory, and afforded a simple and efficient means of providing practical work where this, on any scale necessitating much expense, is impossible.

SECONDARY SCHOOLS.

Attention was directed to education having an agricultural bearing in secondary schools. In most of the secondary schools some form of science teaching had been given for many years previous to 1898. At the first West Indian Agricultural Conference held in January 1899, several valuable papers on agricultural education were read (*West Indian Bulletin*, Vol. I, pp. 77-123), showing the efforts that have been made in the past in some of the colonies and indicating the direction that effort might follow in the future. From this, it was clear that a considerable amount of good work had been done; the energies of the Imperial Department of Agriculture were therefore directed towards assisting and extending these efforts.

In 1899 provisions were made from the funds of the Imperial Department of Agriculture for the services of a Lecturer in Agricultural Science at Harrison College, Barbados, and this officer was so maintained until 1908-9. In addition to this, from 1900 to 1907 an appropriation was made from the funds of this Department, of £90 a year, for five agricultural scholarships tenable at Harrison College; in the year 1907-8 this appropriation was reduced to £50, and then ceased.

From 1900 to 1907, provisions were made from Departmental funds for two scholarships tenable at Harrison College by a scholar from the Windward Islands and one from the Leeward Islands; each scholarship was of the annual value of £75.

Upon the re-establishment of the Government Grammar School in St. Kitts in 1901, the services of an Agricultural and Science Master were provided at the cost of the Imperial Department of Agriculture, and in addition to this, the provision was made for eight agricultural scholarships. The work so inaugurated is still carried on, and has become an integral and valuable portion of the work of this school. In 1907-8 the cost of the maintenance of the Agricultural and Science Master was taken over by the local Government, but the provision for scholarships has been retained as a charge on Departmental funds. Several good successes in agricultural science subjects have been gained at this school, in the Cambridge Local Examinations.

In 1902, a similar arrangement was made in connexion with the Grammar School in Antigua, and an Agricultural and Science Master was appointed and scholarships provided from the funds of the Imperial Department of Agriculture. The number of scholarships was eight, each of the value of £10 per annum, the age limit being sixteen; in 1907 the number was reduced to seven. Agricultural teaching has not been confined to the holders of these, for other boys in the school have shown a desire to receive the agricultural instruction that was given, and have attended the classes in exactly the same way as the agricultural scholars. The general scheme for the agricultural science teaching at the Grammar School has been for every boy to take up chemistry and botany, while in the lower forms, and then for those desiring agricultural instruction only, to specialize when the last form but one (the fourth) is reached, when some of the subjects in the ordinary curriculum are no longer taken up, in order that room may be found for those included in the agricultural teaching. The chief advantages of this plan have been the circumstance that it allows every boy in the school to acquire some knowledge of scientific subjects, at any rate; it enables the agricultural pupils to learn something of subjects that they will take up in a more advanced way when they come to specialize; and it secures a good general education to the agricultural pupils, while these do not suffer from being considered on a different footing from that of the other boys in the school.

The work of the Agricultural and Science Master has also included the giving of lectures to teachers in elementary schools (see above) and to students at the Female Training College in Antigua. These have had special reference to the subjects and methods that would have to be taken up and employed in connexion with nature study in elementary schools; they have chiefly dealt with nature study, elementary plant physiology, the simple principles of plant classification, general science subjects in relation to everyday life, and tropical hygiene. Classes have also been held at the Girls' High School, by the Science Master, the subjects being nature study, systematic botany, and general science in relation to everyday life.

At the Grammar School and the Girls' High School the Cambridge Local Examinations have been employed as the chief test of progress—in the Preliminary, Junior and Senior stages at the former institution, and in the Preliminary and Junior stages at the latter. Several distinctions in science subjects, chiefly in Agricultural Science (Senior), as well as successes in the London Matriculation Examination, have been obtained at the Grammar School. The tests at the Training College were conducted locally, and both in the case of these pupils and of the elementary school teachers, careful and continuous revision of the notes taken at lectures was made.

It may be mentioned that the services of the Agricultural and Science Master, Antigua, have also been employed in Montserrat, for giving the last course of lectures to elementary teachers, recorded in its proper place, above.

An Agricultural and Science Master has been appointed during the current year in connexion with the Government School in Dominica, and it is contemplated that the work in this school will, as regards the teaching of science, soon be placed on a similar footing to that in Antigua and St. Kitts.

In St. Vincent, arrangements have been made during the present year for courses of instruction in science, having an agricultural bearing, to be given to the scholars of the Government School by the Resident Master in charge of the Agricultural School.

Upon the recent re-opening of the Grammar School in Grenada, the post of Head Master was entrusted to a graduate in science—a fact which, taken in conjunction with the present events, affords assurance that science teaching with an agricultural tendency will have careful attention in this Colony.

The results of the increased attention given to science subjects in secondary schools are plainly evident in all the colonies, so that it is not too much to say that very great changes have been effected in the manner in which agriculture is regarded as an occupation. Much assistance has been afforded, both to the instructor and the pupil, by the provision of school gardens at the Grammar Schools, and the work in these has been readily taken up in such a way as to form a popular feature of the curriculum. At the same time, by the spread of a wider knowledge of scientific principles, most useful work has been, and is being, done which has already had a marked influence in hastening agricultural improvements and developments in many places in the West Indies.

THE CADET SYSTEM.

In the secondary schools, as in the primary, care has been exercised to ensure that the subjects taught shall have a real educational bearing, and attempts to teach agriculture in a technical sense have been avoided. The demand for technical teaching of agriculture has been met to some extent as regards pupils both from secondary and from primary schools. In the case of the former, an extended cadet system, to be described immediately, has been originated, while in regard to boys from elementary schools, Agricultural Schools, an account of which is given below, have been inaugurated and carried on.

To afford help to the pupil from the secondary schools an effort was made in 1907, in Antigua and St. Kitts, to secure the co-operation of the Grammar Schools and the Botanic and Experiment Stations. Proposals were put forward to establish what is known as the Cadet System of training. Under this system, boys who under ordinary circumstances would be about to leave school are afforded an opportunity of continuing certain of their studies at the Grammar School, and of spending the remainder of their time undergoing instruction in practical work at the Botanic and Experiment Stations.

At the Grammar School the cadets attend such classes as the Head Master and the Senior Agricultural Officer think expedient, while at the Botanic and Experiment Station they receive instruction in work of an agricultural character relating to the principal crops of the district and the routine work of the Botanic and Experiment Station. While thus receiving a useful technical training, the cadets are made familiar with the general methods of conducting correspondence, the keeping of books, pay lists and records, and they have opportunities of learning how to manage labourers, and to acquire much information of a thoroughly practical character.

In Antigua, opportunities are afforded whereby cadets receive some training in the Government Laboratory, and thus acquire some knowledge of laboratory methods such as are employed in sugar factories, lime juice factories, cotton estates and similar commercial undertakings.

In a few instances, a further means of extending the training of cadets has been provided by arranging that certain junior posts, for which small salaries are paid, shall be held for limited periods by cadets. Among these posts are assistantships for Agricultural Experiments, or posts as foremen in Botanic or Experiment Stations.

The posts are such as entail moderate responsibility, and are of a nature to afford very useful opportunities for an extension and application of the knowledge acquired by the holders as cadets. It is an essential feature of the scheme that these posts in training are only to be held for a limited time by the youths to whom they are given, so that room may be made for affording training to a number of youths in succession

These methods of giving technical training in agriculture have proved quite successful, so that it is expected that the system will be steadily extended as time goes on. They have the effect of dealing with youths at a difficult period in their career, and of affording them an insight into many phases of agriculture work under sympathetic supervision. The schemes also possess the merit that they make use of the Botanic and Experiment Stations as training grounds, without causing additional expense and without in any serious degree interfering with the other functions of these institutions.

AGRICULTURAL SCHOOLS.

In order to provide training in agriculture for the sons of the peasantry, agricultural schools were founded in 1900, in the islands of Dominica, St. Lucia and St. Vincent. These each afforded accommodation for some twenty boys who were boarded and clothed by the institutions, which have been maintained from funds provided by the Imperial Department of Agriculture.

The pupils for training have been chosen from the elementary schools in the several islands, and on admission to the Agricultural School, enter upon a course of training extending over three years; this includes indoor school work embracing courses in agriculture, botany and chemistry, in addition to the teaching of the ordinary school subjects, such as arithmetic geography, reading and dictation, the science subjects being adapted as far as possible to the practical work performed in the field.

The work in the field occupies some three and a half hours a day. and is so arranged as to give the pupils a general practical knowledge of estate work applicable to the district in which they live. Besides the cultivation of the necessary provisions for consumption in the schools, the raising of the staple crops of the district receives special attention. In addition to the routine work in the fields, each pupil is allotted a small garden; he works this alone, and is sole proprietor of the products that he is enabled to raise.

Experiment plots are connected with each school, where investigations concerning existing crops or the introduction of new ones are carried on by the pupils, under the direction of the Officer-in-charge.

During the past year changes have been made in connexion with the Agricultural Schools at Dominica and St. Lucia. The pupils are no longer boarded at these schools, but reside with their parents or with approved persons in the neighbourhood of the Botanic and Experiment Stations. In lieu of the board and clothing, each pupil receives a small monetary grant, to assist in maintaining him during his period of training.

Under the new regulations, the pupils' work in the Botanic and Experiment Stations is conducted under the supervision of the Agricultural Superintendent or his staff, and they are trained in the various field and garden operations having an application in the locality in which the station is situated. Every effort is made to afford the pupils full instruction in those branches of agriculture that they are likely to be required to take up on leaving the school, and to make them thoroughly proficient in performing the various operations connected therewith. In addition to being given this practical training, the pupils are assembled daily for class instruction in various matters of theoretical importance.

It is hoped under this system to afford a thorough training which will result in producing a youth well equipped with a knowledge of his work and with the skill and ability to carry it into effect, thus providing for service with planters young men who can undertake skilled work upon plantations, or who have the ability to work to advantage small peasant holdings that they or their parents may possess.

No change has been made in the manner in which the Agricultural School at St. Vincent is carried on. Here, the pupils continue to be boarded and clothed in the manner originally adopted in the case of all these schools.

READING COURSES AND EXAMINATIONS IN PRACTICAL AGRICULTURE.

In order to afford some further means of technical education for those who passed beyond the reach of the schools—in this case mainly the secondary schools—the Imperial Department of Agriculture in 1908 issued a syllabus of reading courses for the use of those engaged in practical agricultural work, and later organized a series of examinations to test the qualifications of those who desire to enter for the reading courses and take advantage of the tests provided.

The examinations and the work leading to them are divided into three divisions: Preliminary, Intermediate and Final. In order to enter for the Intermediate and Final examinations it is essential that the candidate shall have previously been engaged in practical agricultural work, he must also have passed the Preliminary Examination, or its equivalent. In the preliminary examination, an oral examination, in addition to the written test, is conducted by the local agricultural officers; this is the case with the intermediate and final, but here the officers are aided by practical planters, who have kindly assisted the Department in carrying on this work by conducting the oral examination of these stages. There is thus reasonable assurance that the holders of the certificates issued in connexion with these examinations are properly qualified in the subjects and up to the standard implied by the certificate.

Provision is made for study and examination in connexion with the various staple crops grown in the West Indies, and candidates are required to show proficiency with at least two principal crops.

In fixing standards for the three examinations, it is held that for the Preliminary, a candidate should show such knowledge of agricultural subjects as may be expected of a youth just about to enter upon his training as a planter; this knowledge is now obtainable in most West Indian secondary schools. For the Intermediate, the candidate should exhibit such knowledge as may be expected from a well trained junior overseer who is capable of supervising estate operations and carrying out the general directions of the manager. For the Final, it is expected that the candidate will display such knowledge as may be reasonably looked for in the case of a man to whom the charge of an estate may be entrusted, and in order to obtain a first class Final certificate it is expected that the candidate shall be able to take a broad and intelligent view of general agricultural problems, in addition to possessing sound detailed knowledge respecting some particular branch of agriculture. Candidates in this stage cannot pass unless they show that they have had sufficient educational training to enable them to gain a clear mental grasp of subjects that are presented to them and to express their thoughts in lucid and concise language.

Up to the present time, the number of examinations held has been three in the preliminary stage, two in the intermediate, and one in the final. The total number of candidates examined has been 82, and of these 60 have passed in the different classes. The details are as follows: Preliminary, 51 examined, 37 passed; Intermediate, 24 examined, 18 passed; Final, 7 examined, 5 passed.

Returning again to the reading courses, in addition to the guidance given to students by the syllabus issued by the Department, assistance is afforded by the local agricultural officers in the different islands, who are always prepared to give such help as may be required. In some of the colonies, in order to systematize the aid supplied in this way, and for the purpose of maintaining interest in the work, definite times have been arranged for holding meetings of students, at which particular subjects have been taken up for purpose of affording explanation and demonstration by the local officers. In addition, a 'Students' Corner' has been conducted in the *Agricultural News* since October 1908; this consists of articles that contain seasonal hints and suggestions relating to the work of students, and questions for guidance in reading and in dealing with the subjects designated for study.

OTHER METHODS OF AGRICULTURAL INSTRUCTION.

In connexion with matters relating to agricultural education in its widest sense, reference should be made to the work of the agricultural officers in their endeavours to encourage and supervise the work of agriculturists, and particularly of peasant planters, as regards the introduction of new crops or improvements in the manner of dealing with those that are well known. In many instances the Agricultural Superintendents and their assistants do much work along these lines, which in particular cases devolves upon Agricultural Instructors whose duties it has only been possible to touch upon in the barest outline in the foregoing and other reviews, but whose work has in most instances been of considerable value.

It is impossible to gauge even with approximate accuracy the work done by agricultural officers in the way of instruction in the ordinary course of their duties. This is however very considerable in amount, and of very great service to the colonies in which these officers carry on their work.

Most of the facts given above refer to definite educational work for which the Imperial Department of Agriculture has been responsible or in which it has taken a large part; they include details as to the part that it has played, in a broader sense, in regard to agricultural institutions. There are other matters in which its assistance has been given, however, which require some attention. Among these have been the holding of Agricultural Conferences. There is no need for detailed descriptions of these, in this place, for they have been dealt with already in a former section of this number of the *West Indian Bulletin*, namely on pages 269-74. A second important circumstance in connexion with agricultural instruction in which the Department is interested, has been the development of prize-holdings competitions in Grenada, St. Lucia and Dominica, and lately in Carriacou; these have received little more than mention in passing, in the foregoing pages. The competitions have been held among the peasantry, in the islands named, the procedure being definitely to enter the holdings for examination at some stated future date. During the period leading up to the examination, the agricultural officers have given instruction from time to time to the holders of the areas entered for competition, and in this work they have had useful—in fact, almost indispensable—assistance from planters in the districts in which the holdings were situated. This describes the situation more particularly in St. Lucia and Dominica; in Grenada, the competitions are under the direction of the Agricultural Board and the Agricultural Society, and the reports on the examinations of the holdings are issued by a Committee of planters chosen for the purpose. In whatever way the work has been controlled, the fact of the existence of the competitions has been of the greatest use in providing opportunities for the instruction of the peasantry in proper methods of agricultural procedure, and the various reports show that, although progress was often slow at first, much has been done to effect improvements in peasant cultivation in some of the districts of the islands mentioned, particularly in Grenada and Dominica; the comparatively recent initiation of the competitions in St. Lucia and Carriacou does not yet permit of the existence of results which would enable a similar certain statement to be made concerning the work in those islands. It should be added that competitions of the same kind, but on a larger scale, are held in Jamaica.

In continuation of the subject, reference should be made to the work of agricultural instructors. This has been mentioned several times, and it has been pointed out that, while efforts of the kind have been of the greatest value, there is no means of ascertaining the extent of this in such a way that it could be expressed by means of a short statement. It remains to be added at this stage, that from time to time lectures and demonstrations having reference to special crops and subjects have been given to the peasantry, as they were required, by the agricultural officers; this method of instruction has proved to be particularly useful in the Virgin Islands, mainly in relation to the extension of cotton-growing and of the lime industry.

A last, but most important matter that, considered in its proper aspect, has relation to agricultural education and instruction, is the issue of publications by the Imperial Department of Agriculture. The scope of this part of the work is so large, and its place in the efforts of the Department is of such importance, that it cannot be fairly considered as part of another section. It will therefore be dealt with immediately, under its own heading, as a separate section of this issue of the *West Indian Bulletin*.

PUBLICATIONS ISSUED BY THE IMPERIAL DEPARTMENT OF AGRICULTURE.

The publications issued by the Imperial Department of Agriculture for the West Indies, up to the time of writing. are included in the following generalized list :—

THE WEST INDIAN BULLETIN,

a Quarterly Scientific Journal containing matter of general scientific interest, Vols. I to XI, as follows (the page numbers are those in the different parts):—

Vol. I.	pp. 1-141,	issued	July	1899
	pp. 143-228,	,,	March	1900
	pp. 229-326,	,,	June	1900
	pp. 327-481,	,,	October	1900
Vol. II.	pp. 1-78,	issued	March	1901
	pp. 79-174,	,,	June	1901
	pp. 175-261,	,,	October	1901
	pp. 263-365,	,,	February	1902
Vol. III.	pp. 1-98,	issued	May	1902
	pp. 99-197,	,,	August	1902
	pp. 199-294,	,,	November	1902
	pp. 295-392,	,,	March	1903
Vol. IV.	pp. 1-100,	issued	April	1903
	pp. 101-194,	,,	August	1903
	pp. 195-286,	,,	December	1903
	pp. 287-388,	,,	March	1904
Vol. V.	pp. 1-98,	issued	June	1904
	pp. 99-194,	,,	September	1904
	pp. 195-288,	,,	February	1905
	pp. 289-406,	,,	March	1905
Vol. VI.	pp. 1-98,	issued	June	1905
	pp. 99-246,	,,	August	1905
	pp 247-328,	,,	November	1905
	pp. 329-419,	,,	February	1906
Vol VII.	pp. 1-108,	issued	May	1906
	pp. 109-200,	,,	August	1906
	pp. 201-310,	,,	November	1906
	pp. 311-406,	,,	March	1907
Vol. VIII.	pp. 1-128,	issued	November	1907
	pp 129-228,	,,	November	1907
	pp. 229-312,	,,	January	1908
	pp. 313-408,	,,	January	1908
Vol. IX.	pp. 1-98,	issued	July	1908
	pp. 99-194,	,,	August	1908
	pp. 195-296,	,,	November	1908
	pp. 297-406,	,,	April	1909

Vol. X.	pp.	1-106,	issued	June	1909
	pp.	107-196,	„	September	1909
	pp	197-292,	„	March	1910
	pp.	293-387,	„	May	1910
Vol. XI.	pp.	1-71,	issued	September	1910
	pp.	73-156	„	January	1911
	pp.	157-230	„	April	1911
	pp.	231	„	November	1911

THE AGRICULTURAL NEWS,

the Fortnightly Review of the Imperial Department of Agriculture, dealing generally with agricultural matters, with special reference to the West Indies. This has been published regularly since April 1902, and the issues have reached No. 248 (of Volume X).

[REPORT ON THE WORKING OF THE IMPERIAL DEPARTMENT OF AGRICULTURE FOR THE WEST INDIES,

by Sir Daniel Morris, K.C.M.G. (actually issued by His Majesty's Stationery Office as Colonial Reports—Miscellaneous, No. 36), containing a general report by Sir Daniel Morris on the working of the Department in the West Indies, together with an account of matters discussed at the West Indian Agricultural Conference of 1905. These matters, or references to them, mostly appear in the *West Indian Bulletin*, Vols. V, pp. 335-90; VI, pp. 1-246; in the *Agricultural News*, Vols. I. pp. 49,101,151; III, pp. 180, 390 and 403; IV, pp. 225, 386; and in the *Annual Report on Sugar-cane Experiments in the Leeward Islands*, 1904-5, Pt. 1, pp. 5, 6 and 31.]

NATURE TEACHING,

based upon the general principles of agriculture, for the use of schools, by Dr. Francis Watts, C.M.G., etc., Imperial Commissioner of Agriculture for the West Indies, and others. Three editions of this have been issued, and it has been enlarged twice, the second enlargement making expedient the use of smaller type in order to obviate undue increase in the size of the book. As has been stated already, the later editions include part of a pamphlet, entitled *Hints to Teachers*, prepared under the auspices of the Department, and issued by the Leeward Islands Educational Department for the purpose of assisting in the teaching of nature study and science subjects in the syllabus included in the Code of Regulations for elementary schools. The different issues of *Nature Teaching* were made as follows: First Edition in July 1901, Second Edition in February 1908, Third Edition in September 1910.

THE PAMPHLET SERIES

consists of a series of small booklets dealing in a popular manner with subjects of first interest to agriculturists in the West Indies. These have been issued regularly, and may be classified as follows: Eleven dealing with sugar-cane experiments in Barbados (Nos. 3, 13, 19, 26, 32, 40, 44, 49, 59, 62 and 66). Eighteen dealing with sugar-cane experiments in the Leeward Islands (Nos. 12, 20, 27

30, 33, 36, 39, 42, 46, 47, 50, 51, 56, 57, 63, 64, 67, 68). Five dealing with scale insects and the general treatment of insect pests, (Nos. 1, 5, 7, 22 and 58). Three dealing with fungus diseases of cacao and the general treatment of fungoid pests (Nos. 17, 29 and 54). Five dealing with cotton, cotton-seed-meal and cake, and cotton gins (Nos. 21, 31, 43, 45 and 60). Six dealing with the cultivation of onions, ground nuts, oranges, tobacco and limes (Nos. 16, 21, 25, 37, 38 and 53). Six dealing with the cultivation of various other crops (Nos. 2, 8, 15, 16, 25 and 70). Four dealing with school gardens (Nos. 11, 48, 52 and 65). Three dealing with hints to settlers (Nos. 24, 41 and 69). Two dealing with the cooking of vegetables (Nos. 6 and 18). One dealing with bee-keeping (No. 9). One dealing with millions and mosquitos (No. 55). One dealing with poultry (No. 23).

In addition to these, there are several other pamphlets, not included in the above classification, which treat of miscellaneous subjects that are of interest to the West Indian agriculturist. The total number issued, or about to be issued, to date, is seventy.

ANNUAL REPORTS.

These have been of three kinds—the annual reports on the Botanic and Experiment Stations, those dealing with Sugar-cane Experiments in the Leeward Islands and Barbados, and those indicating progress in Agricultural Education.

Several of them were issued previous to the formation of the Imperial Department of Agriculture; this is true of all the sugar-cane reports. All the botanic and experiment station reports have been published regularly since the first year or two of its existence, except those for Nevis and the Virgin Islands, which began to appear later. Detailed information concerning all these reports has been given in the article commencing on page 351 of this issue of the *West Indian Bulletin*, and it will suffice for present purposes if reference is made to this.

WEST INDIES IN CANADA

is a booklet giving information and statistics concerning the several West Indian Colonies and British Guiana. It is prepared for distribution at the large Canadian Exhibitions in which these colonies are interested, and has been issued regularly since the year 1906. In addition to the part concerned more directly with the West Indies and British Guiana, this contains an illustrated portion giving brief popular accounts of fruits and other agricultural products that are raised in these latitudes.

LEAFLETS.

These have been issued as they are required. They mostly deal with subjects of local or temporary interest, and do not need any special description here.

(Pages 231 to 450 issued November 1, 1911.)

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FOR THE WEST INDIES.

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